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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

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THE AMERICAN PHYSICAL SOCIETY

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INSTITUTE OF ELECTRICAL ENGINEERS

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ABSTRACTS 645–1377

VOLUME 53 **FEBRUARY 1950** NUMBER 626

for ***Components & Complete Installations***

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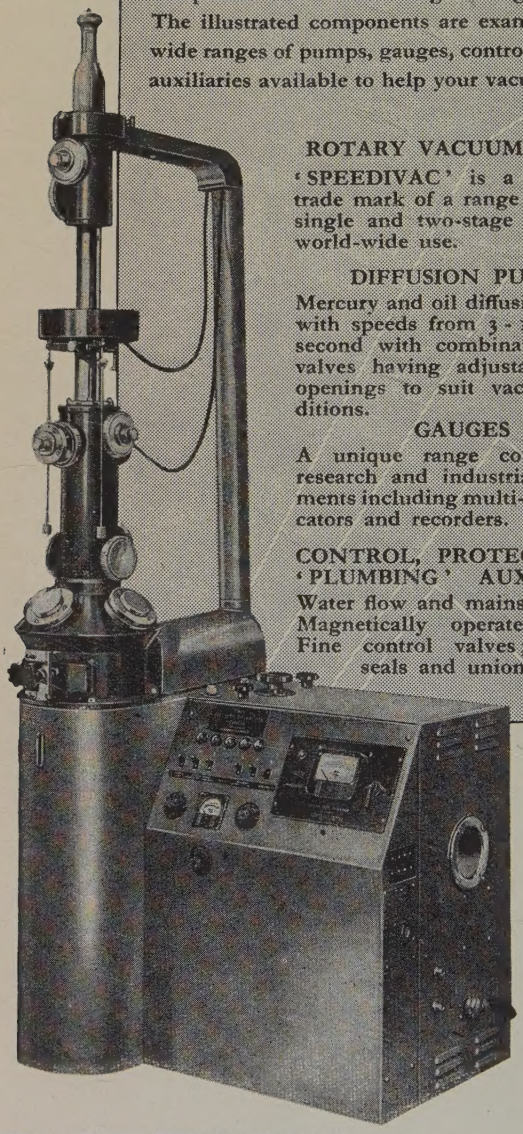
The Finch Electron Diffraction Camera illustrated . . . a powerful research tool for the investigation of surface structure and phenomena . . . is one example of a complete Edwards vacuum plant incorporating the most advanced component and vacuum engineering design. The illustrated components are examples from wide ranges of pumps, gauges, control and other auxiliaries available to help your vacuum work.



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'SPEEDIVAC' is a registered trade mark of a range of famous single and two-stage pumps in world-wide use.

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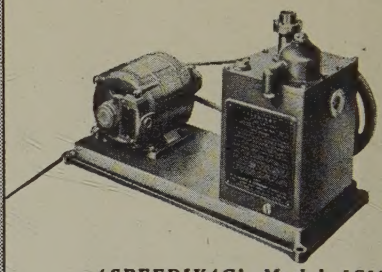
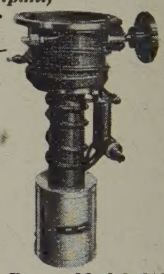
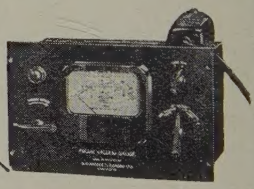


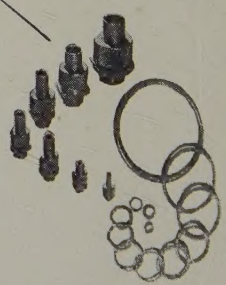
'SPEEDIVAC' Model 1S150 Single-stage. Ultimate vacuum (McLeod gauge) 0.005 mm Hg. Displacement at normal speed (450 r.p.m.) 144 litres/min.



Oil Diffusion Pump Model 202. Two-stage. Ultimate vacuum better than 5 x 10^{-6} mm Hg. Speed (unbaffled) 70-80 litres per sec.



Pirani Vacuum Gauge Model 5, (panel mounting type) Range: 10.0 - 0.001 mm Hg. Also available bench mounted.



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Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

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Ann. Proc. Ass. Sci. Tech. Soc. S. Africa	*Annual Proceedings of the Associated Scientific and Technical Societies of South Africa.* Kelvin House, Johannesburg.
**Bull. Amer. Soc. Test. Mater.*	*Bulletin of the American Society for Testing Materials.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
C.R. Acad. Polonaise Sci. Lett. Cl. Sci. Math. Nat.	*Comptes Rendus Mensuels des Séances de la Classe des Sciences Mathématiques et Naturelles de l'Académie Polonaise des Sciences et des Lettres.* Cracow.
**Diesel Rly Tract.*	*Diesel Railway Traction.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
**Iron Age*	*Iron Age.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
**J. Polymer Sci.*	*Journal of Polymer Science.* [Abstracted by the *Research Association of British Rubber Manufacturers.*]
**J. Tech. Ass. Malaya*	*Journal of the Technical Association of Malaya.* Post Box 664, Singapore.
**Kolloid Z.*	*Kolloid Zeitschrift.* [Abstracted by the *Research Association of British Rubber Manufacturers.*]
Mém. Acad. Polonaise Sci. Lett. Cl. Sci. Math. Nat.	*Mémoires de l'Académie Polonaise des Sciences et des Lettres. Classe des Sciences Mathématiques et Naturelles.* Cracow.
**Mod. Transp.*	*Modern Transport.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
Noise and Sound Transmission	*Noise and Sound Transmission.* Report of the 1948 Summer Symposium of the Acoustics Group. The Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.
**Ottica*	*Ottica (Firenze).* [Abstracted by *Mathematical Reviews.*]
**Paper Tr. J.*	*Paper Trade Journal.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
**Proc. 1st Int. Congr. Rheol. Scheveningen*	*Proceedings of the First International Congress on Rheology*, 1948. North Holland Publishing Co. [Abstracted by the *British Rheologists' Club Bulletin.*]
**Pwr Gener.*	*Power Generation.* [Abstracted by *Metropolitan-Vickers Electrical Co., Ltd.*]
**Rep. Cent. Radio Prop. Lab. (U.S. Bur. Stand.).*	*Report of the Central Radio Propagation Laboratory.* U.S. Department of Commerce, National Bureau of Standards. Washington, D.C.
Resonant Absorbers and Reverberation	*Resonant Absorbers and Reverberation.* Papers and discussions of the First Summer Symposium of the Acoustics Group, 1947. The Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.
**Rev. Gén. Caoutch.*	*Revue Générale du Caoutchouc.* [Abstracted by *Research Association of British Rubber Manufacturers.*]
**Rev. Inst. Franç. Pétrole*	*Revue de l'Institut Français de Pétrole.* [Abstracted by *Fuel Abstracts.*]
Roy. Inst. Techn., Stockholm, Avh.	*Royal Institute of Technology, Avhandlingar.* Stockholm, Sweden.
**Rozpravy II Třídy České Akad.*	*Rozpravy Ceské Akademie Věd a Umění Třída II. (Matematicko-Přírodovédecká.)* [Abstracted by *Mathematical Reviews.*]
**Scientia*	*Scientia.* 4 Via Roncaglia, Asso, Como.
Svenska VattenkrFören. Publ. Medd.	*Svenska Vattenkraftföreningens Publikationer. Meddelande.* Norrlandsgatan 16, Stockholm.
Vortr. Schr. Deutsch. Akad. Wiss. Berlin.	*Vorträge und Schriften. Deutsche Akademie der Wissenschaften zu Berlin.* Akademie-Verlag, Schiffbauerdamm 19, Berlin, N.W.7.

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MATHEMATICS 51

518.5

645. Linear equation solvers. F. J. MURRAY. *Quart. Appl. Math.*, **7**, 263–74 (*Oct.*, 1949).

The type of machine used as an equation solver is described in the author's book: *Mathematical Machines* (New York, 1947). These machines may function continuously or in discrete steps. The necessary and sufficient conditions are found that the machine should successfully solve the system of equations, $\Sigma a_{ij}x_j = b_i$ $(i = 1, 2, \ldots, n)$. The conditions are analogous to stability conditions for a linear network. An adjusting machine with a linear feedback network, which is independent of the coefficients of the equations, will not always operate successfully. L. S. GODDARD

518.5

646. Electronic calculating machine development in Cambridge. M. V. WILKES. *Nature, Lond.*, **164**, 557–8 (*Oct.* 1, 1949).

A brief outline of the EDSAC together with some performance figures. The evaluation of Airy's integral $Ai(-x)$ by the numerical solution of the differential equation $y'' + xy = 0$ is followed through as an example of the expression of problems in a suitable arithmetic form and of the setting up of orders for the machine. A. J. KENNEDY

518.5

647. The differential analyser at the Institute for Practical Mathematics (Darmstadt). A. WALTHER AND H.-J. DREYER. *Naturwissenschaften*, **36** (*No.* 7) 199–206 (1949) *In German.*

Built during and since 1938. Electromagnetically coupled (magslip type). Contains automatic curve-followers and similar triangle multipliers. In the integrator a wheel is made to follow the prescribed tangential direction over a plane. The point of contact traces out the integral curve. Integration and multiplication are correct to $< 0{\cdot}1\%$ and a curve is followed with an error $< 0{\cdot}1$ mm. Coupling errors are negligible. Overall error is $< 1\%$ of ordinate. Setting-up time is about 30 min. S. MICHAELSON

518.5

648. General review of modern calculating machines. A. VAN WIJNGAARDEN. *Ned. T. Natuurkde*, **15**, 244–54 (*Oct.*, 1949) *In Dutch.*

A semi-popular account. E. P. WOHLFARTH

518.5

649. A note on the checking of variable gears as used for integrators. R. BUTLER. *J. Sci. Instrum. Phys. Ind.*, **26**, 342–4 (*Oct.*, 1949).

A new technique is described for the accurate determination, with reference to some given scale, of the zero of a variable gear of the Bush type. Advantages over the now existing methods are claimed. A.

518.5 : 621.318.572

650. The University of Manchester universal high-speed digital computing machine. T. KILBURN. *Nature, Lond.*, **164**, 684–7 (*Oct.* 22, 1949).

Outlines principles of design of this machine. It is a 40 binary digit serial machine with magnetic drum stores for 40 960 digits and c.r.t. stores for 5 120 digits. Division is programmed. Instructions are 20 digits long in a 1 address code and are modified internally. Addition time $\simeq 1{\cdot}8$ msec.

S. MICHAELSON

518.5 : 621.318.572 : 621–52

651. Investigation of non-linear systems of automatic regulation by method of combination of tested objects with an electro-integrator. G. L. POLISAR. *Izv. Akad. Nauk, SSSR, Otdel Tekh. Nauk* (*No.* 3) 384–95 (*March*, 1949) *In Russian.*

Systems of linear differential equations with constant coefficients can be solved using an electronic-valve integrator. Functional changers (output being a known approximation to a given function of input) permit values of coefficients to be obtained from variables and their derivatives. An electromechanical system designed for approximate solution of non-linear differential equations can be adapted for solving partial differential equations and indirectly non-linear differential equations up to the 8th order with non-linearities characteristic of regulating systems. All units are converted to electrical, time scales are unified and models and parts of the actual system may be used. The operation of an automatic regulator of water temperature in an aero engine is analysed.

J. LUKASZIEWICZ (R)

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.038 : 530.1

On the angle between the magnetic and rotational axes of stars. *See Abstr.* 693

521.042 : 539.17

Cosmic nuclear abundance and natural β-activity. *See Abstr.* 1201

521.042 : 539.17

On the equation of state at high temperatures and densities. *See Abstr.* 1202

523.1 : 530.12

An example of a new type of cosmological solutions of Einstein's field equations of gravitation. *See Abstr.* 702

523.11 : 530.12

652. On relativistic cosmogony. G. GAMOW. *Rev. Mod. Phys.*, **21**, 367–73 (*July*, 1949).

The cosmological consequences of general relativity are discussed in relation to observational evidence.

Agreement with observed galactic red shifts and space densities is to be expected with a non-zero cosmological term if allowance is made for possible variations of luminosities with age [cf. Abstr. 410 (1949)]. Recent applications of general relativity to account for the origin of elements and the separation of galaxies [Abstr. 407–9 (1949)] are described, and difficulties arising from considerations of gravitational instability in an expanding universe are discussed.

R. A. NEWING

523.11 : 530.12

653. The age of the universe. R. C. TOLMAN. *Rev. Mod. Phys.*, **21**, 374–8 (*July*, 1949).

Homogeneous expanding models of general relativity are examined in relation to estimates of the age of the universe derived from stellar dynamics and from radioactive decay. Difficulties as to time scale could be avoided by adopting a non-homogeneous model [see Abstr. 2327 (1949)]. R. A. NEWING

523.12 : 530.13

654. Formation of the stars and development of the universe. P. JORDAN. *Nature, Lond.*, **164**, 637–40 (*Oct.* 15, 1949).

An inductive approach to the author's theory of cosmology is provided by a discussion of dimensionless constants of order unity constructed from cosmological data. The relation $kM \simeq R$ is interpreted as a consequence of the conservation of energy, the negative gravitational energy of the universe being equal to the total rest energy of matter. Microphysical units of mass and length are compared with M and R, and it is concluded that $M \propto A^2$, $k \propto A^{-1}$, A being the age of the universe. It is suggested that the implied continuous creation of matter in space leads to the appearance of stars of masses $\propto A^{3/2}$, the radii being such that the total energies are zero.

R. A. NEWING

523.441

655. A new asteroid with the smallest known mean distance. R. S. RICHARDSON. *Publ. Astr. Soc. Pacif.*, **61**, 162–5 (*Aug.*, 1949).

523.48

656. The diameter of Neptune. G. P. KUIPER. *Astrophys. J.*, **110**, 93–4 (*July*, 1949).

The weighted mean of a series of observations of the dia. of Neptune using (*a*) a disc meter showing an artificial disc which is matched to that of the planet, and (*b*) a double-image micrometer, leads to an angular dia. at mean distance of $2{\cdot}004'' \pm 0{\cdot}016$, which departs considerably from previously accepted values. Revised values for density and albedo are given. M. W. OVENDEN

523.5

657. Meteors in the upper atmosphere. C. DE JAGER. *Ned. T. Natuurkde*, **15**, 193–202 (*Aug.*, 1949) *In Dutch.*

A brief survey of the theory of meteoric phenomena is followed by a discussion of methods of observation and the conclusions derivable as to the constitution of the upper atmosphere. A description is also given of certain electronic techniques for the observation of meteors, and of results which have been obtained.

E. P. WOHLFARTH

523

658. Survey and outlook of the study of meteor C. HOFFMEISTER. *Naturwissenschaften*, **36** (*No.* 68–93 (1949) *In German.*

523.53

659. The daytime meteor streams of 1948. Measurement of the activity and radiant position A. ASPINALL, J. A. CLEGG AND A. C. B. LOVEL *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 352–8 (1949).

The 1947 observations by radar [Abstr. 28 (1949)] are continued in 1948. The presence of series of intense radiants lying to the *N.* of th ecliptic between 330° and 120° in R.A. is confirme and 4 further major showers in July and early Augu have been discovered. A. HUNTE

523.53

660. The daytime meteor streams of 1948. I Measurement of velocities. C. D. ELLYETT. *Mo Not. Roy. Astr. Soc.*, **109** (*No.* 3) 359–64 (1949).

Meteor velocities are deduced by measuring th amplitudes of the first 60 pulses returned from th meteor trail. From 61 trails observed betwee June 25 and August 6, 1948, geocentric velocities a obtained for the 54-Perseids and θ-Aurigids. Th corresponding uncorrected heliocentric velocities a respectively $39{\cdot}1 \pm 2{\cdot}6$ and $27{\cdot}5 \pm 1{\cdot}4$ km/s, sho ing that the orbits of both streams are elliptical.

A. HUNTE

523.

661. On the photometry and colorimetry of clos double stars. P. MULLER. *C.R. Acad. Sci., Pari* **228**, 981–3 (*March* 21, 1949) *In French.*

523.6

662. The spectrum of comets Bester 1947 *k* an Honda Bernasconi 1948 *g*. C. FEHRENBACH AN G. COURTÈS. *Ann. Astrophys.*, **12** (*No.* 1) 66–7 (1949) *In French.*

The spectra of these comets are almost identica wavelengths and intensities of emission lines an bands are given for the second. Analyses of th Swan bands and the violet CN bands give temps. c rotation and of vibration which are approximatel the same, with good agreement between the tw comets. The strong emission bands between 5 90 and 6 500 Å differ from the flame spectrum of NH and this possible identification needs confirmation.

D. L. EDWARD

523.6

663. Discussion on the possibility of the presenc of OH$^+$ in cometary spectra. R. HERMAN AN L. HERMAN. *Ann. Astrophys.*, **12** (*No.* 1) 52–6 (1949) *In French.*

Lab. wavelengths, measured with a dispersion c 5 Å/mm, are tabulated for the range 3 989–4 044 Comparisons with cometary spectra and wit Hunaerts's computed values for the (0,1) band of th $^3\Pi$–$^3\Sigma$ system of OH$^+$ suggest no marked contribu tion of the latter to the 4 050 group in cometa spectra. D. L. EDWARI

523.6

664. New method of excitation o the cometa emission bands at 4 050 Å. A. MONFILS AND B. ROSE Letter in *Nature, Lond.*, **64**, 713 (*Oct.* 22, 1949).

The band was found as a strong emission in th

hollow cathode discharge in pure H, and displays many features reported in cometary spectra. Moment of inertia deduced from the observed fine structure indicates that the usual identification with the CH_2 molecule is incorrect, a conclusion confirmed by the absence of any noticeable shift of the bands when H is replaced by D. M. W. OVENDEN

523.72

665. Simultaneous observations of solar radio noise on 1·5 meters and 10·7 centimeters. A. E. COVINGTON AND W. J. MEDD. *J. Roy. Astr. Soc. Can.*, **43**, 106–10 (*May–June*, 1949).

A brief account of the nature of solar noise on various wavelengths between 1 cm and 2 m, correlations with transient phenomena on the solar surface, and probable locations of origins, is followed by a detailed description of the apparatus used at the National Research Council, Ottawa, for the simultaneous recording on 1·5 m and 10·7 cm. Typical traces are shown which contrast the rapid fluctuations on the longer wavelength with the more quiescent behaviour on the shorter wavelength. M. W. OVENDEN

523.72

666. Eclipse observations of solar radiation at a wavelength of 50 cm. W. N. CHRISTIANSEN, D. E. YABSLEY AND B. Y. MILLS. *Nature, Lond.*, **164**, 569–70 (*Oct.* 1, 1949).

The observations indicate that (1) certain small areas on the solar surface (generally sunspot areas) have a greater radio brightness than their background and provide about 20% of the measured radiation from the sun; (2) about ½ of the quiet sun radiation originates close to, and predominantly outside, the visible disc of the sun; (3) at the time of the observations the upper limit of the surface magnetic field strength at the pole was about 8 gauss.

W. J. G. BEYNON

523.74 : 523.877

667. The curvature of the layers of the solar atmosphere, its incidence on darkening and on the function *J*. P. PROISY. *C.R. Acad. Sci., Paris*, **229**, 467–9 (*Aug.* 22, 1949) *In French.*

An earlier general expression for $I(\tau, \theta)$ [Abstr. 3042–3 (1947)] is used to isolate terms arising from curvature. The emission function J for a plane parallel atmosphere is replaced by JR, where R is a function of both θ and τ. R. A. NEWING

523.746

668. The magnetic fields of the sunspots. W. GROTRIAN. *Naturwissenschaften*, **35** (*No.* 11) 321–9 (1948) *In German.*

A comprehensive account of various experimental methods available for the exploration of the magnetic fields of sunspots. The results obtained are critically discussed, from Hale's original determinations of solar Zeeman effects in 1908 up to its latest much improved developments, mainly due to work at the Einstein Solar Tower in Potsdam. There, through the exclusion of falsifying Doppler effects, the accuracy in the measurements of weak magnetic fields could be increased up to some ± 20 gauss. The essential empirical conclusions are tabulated, and proposals for the regular check on interesting sunspot regions and the recording of these surveys are discussed, as well as the observed structures and inclinations of the magnetic lines of force in them. Of particular interest appears the newly discovered centre-limb relationship of the observed spot field strengths. Regarding the general magnetic field of the sun, the questions as to its existence, intensity and orientation have still to remain open. A. BEER

523.746

669. The magnetic fields of the sunspots. W. GROTRIAN. *Naturwissenschaften*, **35** (*No.* 12) 353–61 (1948) *In German.*

The theoretical attempts to explain the observational facts derived from solar magnetic fields are critically discussed, formulae and empirical laws given, and particular reference made to the work of Cowling, Alfvén and collaborators, who include electrodynamical as well as thermo- and hydrodynamical considerations. The motion within bipolar groups, the character of the attraction forces, and the total magnetic energy of a spot region are examined. Numerical estimates of the probable time required for the building up and for the decay of such a region are worked out. The representation of spot turbulence and of other phenomena originating beneath the sun's surface is given, mainly on the basis of theories by Alfvén and Walén, who postulate a complicated system of electromagnetic and hydrodynamical waves in the sun's interior. Relationships between active spot regions and flares, prominences and corona are discussed, as well as the recent ideas about the general magnetic field of celestial bodies by Blackett. Numerous diagrams and an extensive bibliography are added. A. BEER

523.75 : 537.591

670. Solar flares and the origin of cosmic radiation. I–II. J. CLAY, H. F. JONGEN AND A. J. DIJKER. *Proc. K. Ned. Akad. Wet.*, **52** (*No.* 8) 899–914 (1949) *In English.*

Amsterdam records of cosmic-ray intensity for the year 1947 are examined. 30 cases of marked increase of intensity and 30 more cases of slight increase, all correlated with observed solar flares, were found, the delay between flare max. and cosmic-ray intensity max. being up to 2 hr. Selected examples are considered in detail, together with the physical characteristics of the associated sunspot groups. A brief discussion of present theories of cosmic rays in the light of these observations is included.

M. W. OVENDEN

523.752

671. The emission of radiation from flares. R. G. GIOVANELLI. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 337–42 (1949).

The electromagnetic theory of flares [Abstr. 3690 (1949)] is shown to hold for an ionized chromosphere. Upper limits are derived for the temp. (200 000°K) and the electron density (10^{13} per cm^3) in a typical flare. A. HUNTER

523.752 : 550.385

672. An investigation into the possibility of observing streams of corpuscles emitted by solar flares. F. D. KAHN. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 3) 324–36 (1949).

The possibility of verifying spectroscopically the

corpuscular theory of magnetic storms is discussed theoretically. The mode of expansion and state of ionization of a stream of particles emitted by a solar flare are investigated. The only possibility of detection lies in observing absorption to the violet of the *H* and *K* lines of Ca II soon after the end of the flare. The results already announced [Abstr. 3020 (1947)] of such observations during the progress of the following magnetic storm lead to estimates of the stream density which are so high as to be incompatible both with the corpuscular theory and with the flare spectra. A. HUNTER

523.77

673. Visual investigation of the general magnetic field of the sun. G. THIESSEN. *Z. Astrophys.*, **26** (*No.* 1) 16–30 (1949) *In German.*

The solar general magnetic field has been re-examined interferometrically in the years 1947–48, using the 60 cm refractor of the Hamburg–Bergedorf Observatory. The important result appears established that at this period no field > 5 gauss existed in the direction originally measured by Hale. There was even an indication of a very weak field of opposite orientation. A. BEER

523.774

674. Variation of CH lines over the sun's disc. J. C. PECKER. *Ann. Astrophys.*, **12** (*No.* 1) 9–20 (1949) *In French.*

Measurements of the equivalent widths of 3 lines belonging to the λ4300 band of CH show that between the limb and the centre of the sun's disc the intensity of this band passes through a max. The theoretical examination of the intensity of these lines shows that they are due to pure scattering and also that it is necessary to introduce a "roughening-effect" for the sun's surface. A. BEER

523.774

675. The centre-limb variation of the Balmer lines $H\alpha$ to $H\delta$ on the sun's disc. P. TEN BRUGGENCATE, H. GOLLNOW, S. GÜNTHER AND W. STROHMEIER. *Naturwissenschaften*, **35** (*No.* 10) 312–13 (1948) *In German.*

Summary of the observing programme undertaken at Göttingen Observatory during summer 1947 to investigate the changes in the line profiles at relative distances 0·0, 0·6, 0·8, 0·9, 0·95, 0·98 and 0·99. [See also Abstr. 676 (1950)]. The grating spectrograph, focal length 800 cm, was used in the 1st and 3rd order, giving linear dispersions of 2·0 and 0·6 Å/mm, respectively. Necessary instrumental corrections were $< 1\%$. The line intensities are tabulated as I/I_0, i.e. in units of the adjacent continuum. Assuming de Jager's values for the structure of the sun's atmosphere [*Proc. K. Ned. Akad. Wet.*, **51** (*No.* 6) (1948)], and Holtsmark's theory of the Stark effect, a comparison of the new observations with the theory gives at the centre of the sun for all 4 Balmer lines a good agreement. (Permitting an uncertainty of 1–2% in fixing the continuous background). Near to the limb, however, the calculated line depths are always $<$ the observed ones. A small increase of the number of H-atoms in the second quantum state within the highest levels of the solar atmosphere would bring about agreement also for these limb-values. A. BEER

523.77

676. The centre-limb variation of the Balmer lin $H\alpha$ to $H\delta$ on the sun's disc. P. TEN BRUGGENCA H. GOLLNOW, S. GÜNTHER AND W. STROHMEI *Z. Astrophys.*, **26** (*No.* 1) 51–78 (1949) *In German.*

The new tower-telescope of the Göttingen Obse vatory has been used in conjunction with the lar grating spectrograph to obtain spectra of undisturb points of the sun's surface (size of image 225 mm) 7 different central distances, as a function of which t accurate line profiles obtained for the first 4 Balm lines are discussed in detail. Comparisons with oth observational values due to Evans in Oxford an de Jager in Utrecht (sun's image 67 mm) are give as well as a full comparison with theoretical prediction A. BEE

523.77

677. The hydrogen spectrum of the sun. R. GIOVANELLI. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 298–323 (1949).

The profiles of $L\alpha$, $L\beta$ and $H\alpha$ are calculated on th assumption of coherent scattering in a unifor chromosphere at a kinetic temp. of 25 000°K, whic overlies a cooler photosphere. The central intensiti of $L\alpha$ and $L\beta$ correspond to a black-body temp. 11 600°K and do not vary across the solar disc; th of $H\alpha$ is found to be 0·19 of the adjacent continuu as compared with the observed value of 0·12. Th intensity at the beginning of this Lyman continuum 20 000 times that of a 6 000°K black body and th ratio increases rapidly at shorter wavelengths. Th continuum brightens towards the limb. The effect assuming a non-isothermal chromosphere of hot an cool convective columns is discussed. A. HUNTE

523.77

678. Centre-limb variations of Fraunhofer lin breadths and intensities. C. W. ALLEN. *Mon. No Roy. Astr. Soc.*, **109** (*No.* 3) 343–51 (1949).

Breadths, equivalent widths and central intensiti of 20 faint lines in the blue and violet are given acro the solar disc. The broadening towards the limb consistent with a reversing layer in a state of no isotropic large-scale turbulence, with a vertical velocit of 1·74 km/s and a horizontal velocity of 2·79 km/ Equivalent widths increase steadily from centre t limb, but central intensities remain constant. A. HUNTE

523.83

679. Brownian motion, dynamical friction, an stellar dynamics. S. CHANDRASEKHAR. *Rev. Mo Phys.*, **21**, 383–8 (*July*, 1949).

The physical assumptions of the theory of Brownia motion are discussed, and it is shown that stell encounters may be regarded as influencing stell velocities in the manner of Brownian motion. Th effect of encounters is analysed into a systematic pa (dynamical friction) together with random fluctu tions. R. A. NEWIN

523.851

680. On star systems whose density varies in tin and space. R. KURTH. *Z. Astrophys.*, **26** (*No.* 100–36 (1949) *In German.*

Further mathematical development and generaliz tion of Chandrasekhar's and Schürer's stell

dynamical solutions of Liouville's equation [see *Principles of Stellar Dynamics* and *Astr. Nachr.*, 273 (1943)]. A. BEER

523.852.21

681. The continuous spectrum of the Orion nebula in the long wavelength region. D. BARBIER. *Ann. Astrophys.*, **12** (*No.* 1) 6–8 (1949) *In French.*

Results from 14 spectra of the nebula compared with β Orionis (assumed $T = 18\,500°$K) show large variations of colour temp. with wavelength, giving 23 500° for the region 6 250–4 500 Å and 10 000° for 5 000–4 000 Å. Results are in agreement with those of Greenstein, and the curve relating intensity and λ cannot be explained by a recombination spectrum of H, alone or with a superposed diffusion of the θ Orionis spectrum. D. L. EDWARDS

523.854.1

682. A study of the galactic structure in a clear region in Cygnus. J. J. NASSAU AND D. A. MACRAE. *Astrophys. J.*, **110**, 40–58 (*Sept.*, 1949).

523.854.12

683. On the explanation of the interstellar calcium- and sodium-lines. C. JENTZSCH AND A. UNSÖLD. *Z. Phys.*, **125** (*Nos* 4–6) 370–85 (1948) *In German.*

It is discussed how the intensity of interstellar lines depends on the concentration of the absorbing atoms and on the distribution of their velocities which are due to thermal origin as well as to turbulence and galactic rotation. It is shown that the Ca II and the Na atoms have different velocity distributions; the superposition of turbulence and galactic effects, and the various curves of growth are therefore studied separately. The number of absorbing atoms above 1/cm², as well as the mean turbulence velocity as function of the distance, are calculated. The newly derived velocity distribution also explains why, in agreement of the theory with observation, the effects of galactic longitude are so unexpectedly small.

A. BEER

523.87 : 535.331

Measurement of *f*-values in the iron spectrum with applications to solar and stellar atmospheres. *See Abstr.* 837

523.874

684. On the spectra of some early type high-velocity stars. G. R. MICZAIKA. *Z. Astrophys.*, **26** (*No.* 1) 11–15 (1949) *In German.*

The spectral characteristics of 8 high-velocity stars of the types *O*, *B* and *A*, using a medium dispersion, are examined and compared with those of stars of normal motion; no peculiarities are found. A. BEER

523.875

685. A luminosity criterion for *F*-stars. U. BECKER. *Z. Astrophys.*, **26** (*No.* 1) 7–10 (1949) *In German.*

Calibration curves are given which represent the connection between the quantum characteristics of the last visible Balmer line with the absolute mag. of the *F*0 and *F*5 stars. Mean values for electron pressure and electron density of these spectral types are calculated. A. BEER

523.877

686. On the spectrum-magnitude diagram of the bright stars in the Pleiades. S. GÜNTHER. *Z. Astrophys.*, **26** (*No.* 1) 31–42 (1949) *In German.*

Applying the results of the 6-colour-photometry by Stebbins and Whitford to stars free from reddening, the correlation between colour-index and the H absorption at the Balmer limit is derived. From the latter and the new classifications by Morgan [*Astrophys. J.*, **81**, 187 (1946)] very accurate spectral types for the 12 brightest stars in the Pleiades can be obtained. These were used to draw a spectrum-magnitude diagram and to evaluate the reddening effect of the stars. A discussion of the relationship between colour excess and the nebulae in the Pleiades is added. A. BEER

523.877

687. The hydrogen absorption in stars of spectral types *B* to *F*. G. MICZAIKA. *Z. Astrophys.*, **25** (*Nos* 1–2) 77–91 (1948) *In German.*

For 29 *A*, *B*, and *F* stars the total absorption of the Balmer lines has been studied, and the number of H atoms in the second quantum state above 1/cm² of the star's surface evaluated. For 5 early *B* stars the number of free electrons and H atoms, electron pressure and the gravitation effect are calculated. Agreement is found with Unsöld's results derived from a different material. A. BEER

523.922.2

688. The determination of integrated ultraviolet-magnitudes with refractors. H. HAFFNER. *Z. Astrophys.*, **26** (*No.* 1) 79–99 (1949) *In German.*

A contribution to the promising field of integral stellar photometry [see W. Becker, *Göttingen Veröff.* (*Nos* 79–82) (1946)]. Quasi-monochromatic magnitudes are derived for 51 stars in the Praesepe cluster. Their colour-magnitude diagram for λ3730–4270 shows some noteworthy peculiarities. A. BEER

529.781

689. The Greenwich time signal service. H. M. SMITH. *Ann. Franç. Chronom.* (*Sér.* 2) **3**, 227–34 (1949) *In French.*

An account of the relevant technical considerations and the present practice. Mention is made of experiments designed to measure the speed of propagation of signals. There is a good deal of evidence that the reception and measurement errors at Greenwich are 0·3 and 1·0 msec for long and short waves respectively, although the values given (for 1946) by the Bureau International de l'Heure are 2·2 and 3·5 msec. This may be due to the fact that the Bureau values are based on a number of observatories, some of which do not use the most modern methods.

L. ESSEN

PHYSICS 53

53.081 : 537.081

690. Units and dimensions. J. A. PRINS. *Ned. T. Natuurkde*, **15**, 217–27 (*Sept.*, 1949) *In Dutch.*

A general discussion includes reference to the various systems of electrical units, the $(1 + \delta)$ factors relating practical and absolute units, and suggested names and symbols equivalent to very large or small powers of 10. E. P. WOHLFARTH

53.084 : 621.317.7.084

691. The ratio of electrical to friction torques in indicating instruments. G. Szabó. *J. Sci. Instrum. Phys. Ind.*, **26**, 301–4 (*Sept.*, 1949).

The ratio of the electrical torque to the friction torque has been treated, investigating the case of the most favourable value for this ratio. The shock-acceleration and shock-velocity are computed within the range of permanent deformations where pivots and jewels are not impaired. A.

FUNDAMENTALS 530.1

530.1 : 521.038

692. On the gyro-magnetic theory. (Stellar magnetism). A. Dauvillier and P. Henry. *C.R. Acad. Sci., Paris*, **229**, 458–60 (*Aug.* 22, 1949) *In French.*

It is suggested that Venus and Mercury exert a screening action with regard to solar corpuscular radiations, the action being attributed to planetary magnetic fields. Field intensities, estimated from Blackett's relation, are too weak to explain the effect. The authors' ferro-magnetic theory [Abstr. 1395 (1948)] could provide sufficiently strong fields.

R. A. NEWING

530.1 : 521.038

693. On the angle between the magnetic and rotational axes of stars. A. Gião. *C.R. Acad. Sci., Paris*, **228**, 1203–4 (*April* 4, 1949) *In French.*

According to the author's theory of the magnetism of rotating bodies [see Abstr. 2696 (1948)], the inclination of the axes is determined by the non-diagonal terms of the tensor $g^{il}\omega_{lk}$. These terms have been neglected in previous work, and the two axes have coincided. If these terms are not negligible, the magnetic axis will be inclined to the axis of rotation; the inclination should be greater for the earth than for the sun. R. A. NEWING

530.1 : 531.51 : 538.11

694. Theory of the relations between gravitation and electromagnetism and their astrophysical and geophysical applications. A. Gião. *J. Phys. Radium*, **10**, 240–9 (*July–Aug.–Sept.*, 1949) *In French.*

Gives a detailed account of the author's theory in which space-time is regarded as a hypersurface in 5-space, gravitation and electromagnetism being defined by the internal and external metrics [see Abstr. 2328 (1949)]. Applications to the magnetism of rotating bodies are summarized [Abstr. 2696, 3026–7 (1948); 3745 (1949)]. A fundamental relation between gravitational and electrostatic fields suggests an explanation of the terrestrial e.s. field.

R. A. NEWING

530.1 : 531.51 : 538.11

695. The equations of Codazzi and the relations between electromagnetism and gravitation. A. Gião. *Phys. Rev.*, **76**, 764–8 (*Sept.* 15, 1949).

The aim of this paper is to show that, quite independently of any physical theory, the general equations of Codazzi on differential geometry lead to fundamental relations between the electromagnetic and the gravitational fields as soon as the external metric tensor of space-time is interpreted as an electromagnetic tensor. When the important special case of quasi-static fields is considered, one obtains for a rotating body with no permanent magnetization: (1) the relation, previously studied by the author, between magnetic moment and angular momentum which explains the general features of stellar and terrestrial magnetism as well as the magnetic moment of the neutron; (2) a relation between gravitation and the electrostatic field, such that any massive body creates an electrostatic field by its own gravitation. The mean electrostatic fields of celestial bodies including the earth, can be ascribed to this effect. When the gravitation produced by a given body is negligible (as in the laboratory) the equations of Codazzi show that the familiar Coulomb field is merely a consequence of the very rapid vibrations of the components g_4i ($i = 1, 2, 3$) of the internal metric tensor. Finally, for an uncharged body with permanent magnetization it can be shown that the curl of the g_4i and the magnetic field are related as cause and effect. Thus the geometrization of electromagnetism must necessarily be achieved by the external metric of space-time. A.

530.1 : 538.11

696. A difficulty in using $mk^{\frac{1}{2}}$ as a residual charge to explain stellar magnetism. P. D. P. Smith. Letter in *Phys. Rev.*, **76**, 690 (*Sept.* 1, 1949).

The charge associated with mass in Mariani's theory [Abstr. 2320 (1948)] is such that electrostatic repulsion would cancel gravitational attraction.

R. A. NEWING

530.12 : 531.51

697. The gravitational cosmological constant and the Gaussian equations for a hypersurface. A. Gião. *C.R. Acad. Sci., Paris*, **228**, 812–13 (*March* 7, 1949) *In French.*

Regarding space-time as a hypersurface in 5-space [Abstr. 694 (1950)] the Gaussian equations are used to express the cosmological constant in the form $\lambda_g = 6\chi^2 + 4\chi\bar{\omega}_{44} - \kappa T$, where $\bar{\omega}_{ik}(=\omega_{ik} - \chi g_{ik})$ are regarded as small and χ is the mean curvature of space-time. R. A. NEWING

530.12

698. A particular case in Einstein's generalized theory of gravitation. V. V. Narlikar and R. Tiwari. Letter in *Phys. Rev.*, **76**, 868–9 (*Sept.* 15, 1949).

An Hermitian field is set up, the purely gravitational part of which corresponds to a point mass and the purely electromagnetic part to a uniform field of monochromatic radiation. R. A. NEWING

530.12

699. On the motion of test particles in general relativity. L. Infeld and A. Schild. *Rev. Mod. Phys.*, **21**, 408–13 (*July*, 1949).

The geodesic motion of a test particle of small mass m in an arbitrarily strong external field is derived from the field equations for empty space. The metric field is expanded in powers of m, and it is shown that when $m \to 0$, the field equations impose the condition that the world line of the particle is a geodesic of the external field. The result also holds

for motion in a non-gravitational field if there is only gravitational interaction between the particle and the field. R. A. NEWING

530.12

700. Some results in Einstein's unified field theory. E. G. STRAUS. *Rev. Mod. Phys.*, **21**, 414–20 (*July*, 1949).

The equations $g_{ik,\,l} = 0$, where g_{ik} is the Hermitian metric tensor, are solved for the affine connections, and the equations $R^{i}_{klm} = 0$ are discussed. It is shown that a mass-particle cannot be represented by a static solution of the field equations which is everywhere regular, and that there are no non-trivial regular static centrally symmetric solutions which are asymptotically flat. R. A. NEWING

530.12 : 531.18

701. Postulate versus observation in the special theory of relativity. H. P. ROBERTSON. *Rev. Mod. Phys.*, **21**, 378–82 (*July*, 1949).

Postulates are replaced as far as possible by inductions from observation. The metric $g_0^2dt^2 - (1/c^2)[g_1^2dx^2 + g_2^2(dy^2 + dz^2)]$ is associated with a reference frame moving with speed v relative to a "rest system," the g's being functions of v. The Michelson–Morley and Kennedy–Thorndike [Abstr. 488 (1933)] experiments on the velocity of light imply $g_0 = g_1 = g_2 = g(v)$. The Ives–Stilwell experiments [Abstr. 1737 (1941)] on the rate of a moving atomic clock imply $g(v) = 1$ correct to terms of order $(v/c)^2$. R. A. NEWING

530.12 : 523.1

702. An example of a new type of cosmological solutions of Einstein's field equations of gravitation. K. GÖDEL. *Rev. Mod. Phys.*, **21**, 447–50 (*July*, 1949).

Discusses the properties of a 4-space defined by the metric $a^2[(dx_0 + e^{x_1}dx_2)^2 - dx_1^2 - \frac{1}{2}e^{2x_1}dx_2^2 - dx_3^2]$, where a is a constant. This is shown to be a solution of the field equations with a non-zero cosmological term, and is interpreted as a stationary, spatially homogeneous universe in which matter rotates with angular velocity $2\sqrt{(\pi\kappa\rho)}$. There is no red shift for distant objects, and cosmic time, definable without reference to individual objects, does not exist. R. A. NEWING

530.12

703. Non-symmetric stress-energy-momentum tensor and spin-density. A. PAPAPETROU. *Phil. Mag.*, **40**, 937–46 (*Sept.*, 1949).

A possible physical meaning for the tensor is discussed. It is shown that an antisymmetric part arises necessarily if there are particles with spin which must be considered as point particles. Formulae connecting the antisymmetric part of T_{ik} and the spin density are derived. It is shown that the unified field theory of Einstein and Straus with non-symmetric metrical tensor will not explain geomagnetism. L. S. GODDARD

530.132

704. Spontaneous fluctuations. D. K. C. MACDONALD. *Rep. Phys. Soc. Progr. Phys.*, **12**, 56–81 (1948–49).

Two main topics are reviewed: (1) mathematical methods of fluctuation analysis; (2) fluctuation phenomena studied during the last decade. The former includes a discussion of the solution of the equation, $mdu/dt + \lambda u = F(t)$, where $F(t)$ is a rapidly fluctuating force term whose average is zero but which has a mean-square value. The question whether "noise" has a frequency is discussed, and analytical concepts such as the correlation function, and correlation interval are explained. The importance of the work of Rice and of Fränz in the interpretation of experimental studies in the diffraction of radio waves in the ionosphere is pointed out. The use of inversion theorems in the study of noise is discussed. In (2) the subjects discussed are (*a*) electrical noise, (*b*) valve noise problems, (*c*) low-frequency noise in valves and semi-conductors, (*d*) spontaneous fluctuations of temp. and radiation. L. S. GODDARD

530.14 : 533.15

On the relativistic correction in some problems of diffusion. *See Abstr.* 774

530.145

705. Electromagnetic interactions of a vector meson with a scalar excited state. M. N. ROSENBLUTH. *Phys. Rev.*, **76**, 951–7 (*Oct.* 1, 1949).

A relativistically invariant formalism is presented for a theory of a meson possessing a vector and a scalar state of different mass which are tightly coupled by the electromagnetic field. It is found that the theory reduces formally to the theory of a 5-dimensional vector meson, with the constant which couples the states playing the role of a fifth component of the energy-momentum vector. With a large coupling constant there is a high probability for producing excited-state mesons, and hence decay photons, in electromagnetic processes; e.g. by Rutherford scattering on passage of a beam of mesons through heavy material. The production of many photons in nucleon-nucleon scattering, such as has been reported at Berkeley, might possibly be interpreted as resulting from the decay of excited-state mesons which are produced directly. It is also found that the existence of a scalar excited state aggravates the high energy divergences of vector meson cross-sections for such electromagnetic processes as Compton effect, so that the validity of the Christy-Kusaka argument against the μ-meson having spin 1 is not affected by the possible existence of a scalar excited state. A.

530.145

706. Note on the interaction representation in case of meson field interacting with electromagnetic field. S. KANESAWA. Letter in *Progr. Theor. Phys.*, **4**, 236–8 (*April–June*. 1949).

A generalization of the equations of Kemmer [Abstr. 4466 (1939)]. E. P. GEORGE

530.145

707. Note on the deuteron problem of the mixed meson theory of pseudovector and pseudoscalar fields. S. HIROISHI AND H. TANAKA. Letter in *Progr. Theor. Phys.*, **4**, 231–2 (*April–June*, 1949).

The coupling constant and meson mass-ratio are adjusted to fit the observed proton magnetic moment. The theoretical binding energy of the deuteron then has the wrong sign, and the n,p scattering cross-section is found to be far too low. E. P. GEORGE

530.145

708. The *S*-matrix for meson-nucleon interactions. P. T. MATTHEWS. Letter in *Phys. Rev.*, **76**, 1254–5 (*Oct.* 15, 1949).

For a neutral meson field with vector interaction with nucleons, but not in the other possibilities of meson interactions, it is possible to show that the terms in the derivatives of the field do not directly contribute to the matrix elements of scattering processes, by obtaining the Hamiltonian in the interaction representation. With suitable renormalization, therefore, a finite *S*-matrix for scattering processes can be obtained by Dyson's method [Abstr. 4487, 5940 (1949)]. G. J. KYNCH

530.145

709. An approximate relation between the energy levels of a particle in a field of given potential energy, calculated on the relativistic and non-relativistic theories. G. L. SEWELL. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 631–7 (1949).

Mathematical. This is established by expanding wave-functions and energy in powers of c^{-2} to give excess of Dirac over Schroedinger energy. The result is applied to the Stark effect for an *H* atom in its ground state. In this excess contributions due to relativity and due to spin interaction of particle with field are investigated explicitly: neglecting spin the Klein–Gordon equation is obtained giving ΔE_1 due to relativity. ΔE_2 due to spin can then be found correct to c^{-2}, and total excess $\Delta E = \Delta E_1 + \Delta E_2$.

J. JACOBS

530.145

710. Reciprocity theory of elementary particles. M. BORN. *Rev. Mod. Phys.*, **21**, 463–73 (*July*, 1949).

A summary is given of a number of papers embodying the reciprocity principle. The notion of self-reciprocal functions is applied to a general formulation of the conservation laws and quantization, and the resulting equations lead to a spectrum of masses. The spectrum is given for spin 1. Electron and electromagnetic theory have been developed by Green. A relativistic introduction of a cutting-off factor eliminates divergences. The nucleon is treated on slightly different lines as a point dipole and charge.

G. J. KYNCH

530.145 : 530.12

711. The concept of motion in relativistic quantum theory. YA. I. FRENKEL. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 4) 507–9 (1949) *In Russian.*

Conservation of mass of classical mechanics is replaced by possibility of annihilation and other processes for elementary particles, treated by quantum field theory to calculate probabilities of such processes. This theory is here applied to problem of ordinary motion, treated as disappearance of particle in one place and reappearance in another. In case of electrons this is accompanied by virtual appearance of electron-positron pair, mutual annihilation and reappearance of electron elsewhere. Emission of light is also connected with intermediate states of negative energy, i.e. with appearing and vanishing of electron-positron pair. Dirac's equation of motion refers thus to an unknown number of particles and attains physical meaning only after repeated quantization of the field. For particles with zero rest mass classical motion has no meaning and is replaced by emission in one place, absorption elsewhere. The corpuscular theory is replaced by theory of fields which are carriers of mechanical properties ascribed to particles, energy, spin, quantization of motion. Conservation of these gives field a reality of matter; particles are only convenient models with which to describe field effects.

J. JACOBS

530.145 : 537.122

712. Fourth-order corrections in quantum electrodynamics and the magnetic moment of the electron. R. KARPLUS AND N. M. KROLL. Letter in *Phys. Rev.*, **76**, 846–7 (*Sept.* 15, 1949).

This has been calculated using the transition schemes of Feynmann and Dyson [Abstr. 858, 2333 (1949)]. The correction is $-2{\cdot}973\,(\alpha/\pi)^2$ Bohr magnetons, which is $1\frac{1}{2}\%$ of the 2nd-order correction and of opposite sign to it. G. J. KYNCH

530.145 : 537.133

713. Vacuum polarization in the positron theory. S. T. MA. *Phil. Mag.*, **40**, 1112–28 (*Nov.*, 1949).

The induction tensor is evaluated. The calculation is similar to that of Tati and Tomonaga [*Progr. Theor. Phys.*, **3**, 391 (1948)]. Different methods of handling the divergent integrals which arise could lead to different results. Schwinger's calculation of the effect of vacuum polarization is repeated on the basis of the usual form of perturbation theory for the energy-momentum representation of quantum electrodynamics. The induction tensor is the same as that previously derived. Pauli's regularization is applied to the induction tensor and it is shown that this leads to a divergence-free, relativistically covariant and gauge-invariant result, which is independent of the way in which the integrals are handled during the evaluation. L. S. GODDARD

530.145 : 537.533.74

714. On radiation reactions in collision processes. I. Application of the self-consistent subtraction method to the elastic scattering of an electron. Z. KOBA AND S. TOMONAGA. *Progr. Theor. Phys.*, **3**, 290–303 (*July–Sept.*, 1948).

In the self-consistent subtraction method a mass correction term is included in the particle Hamiltonian and subtracted from the interaction Hamiltonian. Similarly an external potential is "renormalized" by a term involving the vacuum polarization. With this modified interaction, chosen for self-energy and other reasons, the off-diagonal matrix elements are so modified that the scattering cross-section to order e^2 is free from divergent terms previously appearing as radiative correction terms. The calculation is similar to that of Lewis [Abstr. 1749 (1948)]. G. J. KYNCH

530.145 : 537.533.74 : 538.3

715. Theory of the interaction of elementary particles. IV. The problem of vacuum polarization (2). H. UMEZAWA, J. YUKAWA AND E. YAMADA. *Progr. Theor. Phys.*, **4**, 113–20 (*April–June*, 1949).

The 4th-order Compton scattering is examined to see if the subsidiary meson field removes divergences to this order. The conclusion is that it does so, taking account of renormalizations of charge and mass. G. J. KYNCH

530.145 : 538.3

716. Quantum mechanics of canonical field variables. R. CADE. Letter in *Nature, Lond.*, **164**, 713–14 (*Oct.* 22, 1949).

Even on the assumption of quantized space the electromagnetic field may be described by a set of conjugate variables where the eigenvalues of the p are continuous and those of the q are integral multiples of a small constant α. Suitable commutation relations are given, and the eigenvalues of the Hamiltonian of an oscillator are evaluated. For small frequencies the field is apparently described by quanta of energy slightly differing from multiples of $h\nu$ by small terms, interpreted as an interaction between quanta of the same frequency. The main point, however, is that the energy eigenvalues are only real for frequencies below $\hbar/\alpha^2$. A cut-off frequency is thus automatically introduced.

G. J. KYNCH

530.145 : 539.152.1

717. The future nuclear interaction. A. E. S. GREEN. Letter in *Phys. Rev.*, **76**, 870–1 (*Sept.* 15, 1949).

The various types of meson interaction are examined with the help of 3 tests, which should be satisfied by any suitable nuclear interaction.

G. J. KYNCH

530.145 : 539.18

718. Erratum: On the difficulty of the meson theory of nuclear forces. G. ARAKI. *Phys. Rev.*, **76**, 437 (*Aug.* 1, 1949). See Abstr. 5951 (1949).

530.145 : 539.18

719. The application of Dyson's methods to meson interactions. P. T. MATTHEWS. Letter in *Phys. Rev.*, **76**, 684–5 (*Sept.* 1, 1949).

An example is given, to show that these methods [Abstr. 2338 (1949)] for writing down matrix elements can be applied to more general meson interactions containing terms in derivatives. In the interaction representation, these terms lead to Hamiltonians depending explicitly on the direction of the space-like surface. G. J. KYNCH

530.145 : 539.18

720. On meson fields and conformal transformations. J. A. SCHOUTEN. *Rev. Mod. Phys.*, **21**, 421–4 (*July*, 1949).

A history of unitary field theories and the use made of conformal transformations leads to a discussion of the role of a 6-dimensional space in the theory, the energy-momentum tensor including the meson field. The paper ends with an apologia from a mathematician to physicists. G. J. KYNCH

530.145 : 539.18

721. Models and methods in the meson theory. H. YUKAWA. *Rev. Mod. Phys.*, **21**, 474–9 (*July*, 1949).

The spins and other properties of the known mesons are first discussed in terms of the data now available. The possible arrangements of the interactions between the elementary particles are then considered, including the position in the scheme of the possible heavy τ-meson. In the final section on nuclear forces, the relative merits of weak, intermediate and strong coupling theories are discussed in bearing both recent experimental evidence and recent theoretical advances. G. J. KYNCH

530.145.6

722. On the application of the theorem of composite probabilities to wave mechanics. L. DE BROGLIE. *C.R. Acad. Sci., Paris*, **223**, 874–7 (*Nov.* 27, 1946) *In French.*

Some classical results in the theory of continuous random variables are applied to the wave mechanics of a particle moving along a straight line, and expressions are derived for various probability densities. L. S. GODDARD

530.145.6

723. Separation of the variables of the two-particle wave equation. L. P. EISENHART. *Proc. Nat. Acad. Sci., Wash.*, **35**, 490–4 (*Aug.*, 1949).

530.145.6

724. Motion in a constant magnetic field. M. H. JOHNSON AND B. A. LIPPMANN. *Phys. Rev.*, **76**, 828–32 (*Sept.* 15, 1949).

The motion of a charged particle in a constant magnetic field is treated in both relativistic and non-relativistic quantum theory. Operators representing the centre of the orbit, which obey the commutation law for conjugate variables, are introduced and their connections with energy, angular momentum, and magnetic moment studied. Energy eigenfunctions in an operator form are obtained by factorization. Previously derived eigenfunctions in co-ordinate space are obtained and are shown to be eigenfunctions for the operators for the centre of the orbit as well as for the energy. Corresponding relativistic eigenfunctions are derived by a simple device which enables one to construct solutions of the Dirac equation from solutions of the Schrödinger equation. A.

530.145.6

725. Spin and wave function of an elementary particle. P. ROMAN. Letter in *Nature, Lond.*, **164**, 406–7 (*Sept.* 3, 1949).

Matrix equations are given, permitting only a 4-dimensional representation, which give the correct spin and magnetic moment of an electron. They are not Lorentz-invariant, and the wave-functions are not spinors. The electric moment of such a particle is zero. A mutual direct correlation between spin and the transformation properties of the wave-function therefore does not exist in the form generally assumed. G. J. KYNCH

530.145.6

726. Eigenfunctions following from Sommerfeld's polynomial method. A. RUBINOWICZ. *Proc. Phys. Soc., Lond. A*, **62**, 736–8 (*Nov.*, 1949).

The eigenfunctions were determined in the general case. They are products of a convergence factor E and a polynomial P given by a hypergeometric series. The form of E depends upon whether P is expressible by the ordinary or the confluent hypergeometric series. A.

530.145.6

727. Unified theory of recurrence formulae. I. T. INUI. *Progr. Theor. Phys.*, **3**, 168–87 (*April–June*, 1948).

In this reorientation of the work of Infeld [Abstr. 1445 (1941)] and others on the factorization of wave-

equations, an examination is made of the Riemann *P*-functions, to bring to light linear and differential relations between some of the special forms. These relations are then built into a system by means of which recurrence forms or "stair operators" can be built up for any of these functions, which include the hypergeometric functions as special cases.

G. J. KYNCH

530.145.6

728. Unified theory of recurrence formulae. II. T. INUI. *Progr. Theor. Phys.*, **3**, 244–61 (*July–Sept.*, 1948).

The methods used in the previous paper [preceding Abstr.] are applied to the confluent Riemann *P*-functions and a general method of obtaining recurrence relations between them is detailed.

G. J. KYNCH

530.145.6

729. On the charged meson pair theory of nuclear forces. I. O. BRULIN. *Ark. Fys.*, **1**, *Paper* 4, 117–71 (1949) *In English.*

The first section is an extensive calculation using 2nd-order perturbation theory of the potential between two nucleons interacting with meson pairs of scalar or vector type. All the various types of interaction listed by Hjalmars [following Abstr.] are included. The conditions of convergence are then discussed. Initially an exact solution of the field equations for the scalar case is obtained using an extended source model so that the equation is $(\nabla + k^2 - \gamma\Omega)U = 0$ where $k^2 = (E/\hbar c)^2 - \kappa^2$, . κ is the reciprocal meson mass, and Ω is the spherically symmetric source function. This is solved for 3 simple forms for Ω including a square-well source. The self-energy and the interaction between two coincident sources are in all cases found to be infinite. Next perturbation theory is used with a cut-off, and conditions found for the validity of this expansion. Except for an extra condition for the vector mesons, these are found to be the same as those found by other authors, cf. Pauli and Hu [Abstr. 678 (1946)].

G. J. KYNCH

530.145.6

730. On the charged meson pair theory of nuclear forces. II. O. BRULIN. *Ark. Fys.*, **1**, *Paper* 5, 173–91 (1949) *In English.*

The interaction potentials derived in Part I [see previous Abstr.] are simplified to the static approx. and applied to scattering problems. One of many possible types of interaction for vector mesons is chosen to calculate *p–p* scattering, with . meson mass of 177 *m* and an interaction constant and a cut-off radius to give the correct cross-sections at 0·86 and 2·39 MeV. Calculated and experimental cross-sections agree well over the range 0·3–10 MeV. The cut-off is just at the critical range determined by relative importance of spin inertia terms, and a smaller meson mass would reduce it even more. In a final discussion of the various possibilities this agreement is emphasized as the problems of *n–p* interaction can be dealt with in other ways. In an appendix the types of interactions giving large velocity-dependent terms are examined.

G. J. KYNCH

530.145.6 : 530.1

731. On the question of solving relativistic wav equations. F. I. FEDOROV. *Dokl. Akad. Nau SSSR*, **65** (*No.* 6) 813–14 (1949) *In Russian.*

Mathematical. Assuming existence of H^{-1}, ψ = $(1 + H^{-1}U)^{-1}\psi_0$ [ψ_0 unperturbed known wave functio H, U linear operators]. ψ is expanded in a Neuman series which is useful if H^{-1} can be expressed i closed form. Applied to relativistic wave equatio H involves finite square matrices which satisf different equations according as spin is 1 or $\frac{1}{2}$. I general ψ can be expressed as a series of Fouri integrals or with the aid of Green's functions. Th method is particularly helpful for light scattering of free particle, where 1st approximation for ψ coincid with results of earlier calculations. J. JACOB

530.145.6 : 539.152.

732. Note on the iterative method in nuclear prob lems. R. MCWEENY. *Proc. Camb. Phil. Soc.*, **4** (*Pt* 2) 316–18 (1949).

Alternative trial functions are suggested for th momentum space method of Svartholm [Abstr. 134 (1946)] for the 2-body and many-body problems.

G. J. KYNC

530.145.6 : 539.152.

733. An elaboration of the Schrödinger formalis with applications to nuclear physics. J. W. CALKIN Letter in *Phys. Rev.*, **76**, 846 (*Sept.* 15, 1949).

On the assumption that nuclear phenomena ca be described better without a potential but rather b boundary conditions imposed on the wave-functio over some inner surface drawn in configuration space the Schrödinger equation is modified to apply to wave-function defined outside and on that surface The scalar product, mean kinetic energy and th Hamiltonians for such a wave-function are given fo the 2-body problem. Extensions to include spi and exchange properties are readily found.

G. J. KYNC

530.145.6

734. Heisenberg's *S* matrix for a system of man particles. R. J. EDEN. *Proc. Roy. Soc. A*, **198** 540–59 (*Sept.* 7, 1949).

When creation and annihilation of particles i forbidden, the general features of a many-particl collision are illustrated by a scattering system con taining two particles and a fixed scattering centre The term in the wave function, which is called b Møller the "outgoing" part, is shown to contain term representing a totally outgoing wave, but als terms describing the interference effects between th incident wave of one particle and the outgoing wav of the other. Corresponding to the latter terms there exist singular eigenstates of the *S*-matrix whic are simultaneous eigenstates of the separate kineti energies of the particles. The remaining eigenstate are called non-singular, and for these only the sur of the kinetic energies can be given a definite valu Analytic continuation of the non-singular eigenstate in the complex plane of total kinetic energy show that the corresponding eigenvalues of *S* can be use to determine the energy levels of states with bot particles bound to the centre of force. The eige values for the singular eigenstates will lead to th

bound energy of a single particle in the scattering field of the other. The formalism is extended to include singular eigenstates which describe the scattering of one particle on a compound centre made up of the other particle bound to the scatterer. A.

530.162 : 532.51 : 536.48

735. Uncertainty relations and quantum fluids. The configuration space method in quantum kinetic theory. D. MASSIGNON. *C.R. Acad. Sci., Paris*, **228**, 1280–2 (*April* 11, 1949) *In French.*

Classical hydrodynamics may be formulated either by writing down the canonical equations describing the time variation of the density, the momentum, and the kinetic energy, and then taking the mean values, or from Liouville's equation for the time variation of the distribution function. The equations of quantum hydrodynamics may then be deduced by replacing the classical quantities by their quantum analogues. R. B. DINGLE

530.162 : 532.51 : 536.48

736. Uncertainty relations and quantum fluids. Second quantization in quantum kinetic theory. D. MASSIGNON. *C.R. Acad. Sci., Paris*, **228**, 1331–3 (*April* 20, 1949) *In French.*

A further formulation of quantum hydrodynamics is obtained [See Abstr. 735 (1950)]. In this, the concepts of second quantization are introduced and operators of annihilation and creation play an essential role. R. B. DINGLE

530.162 : 533.7

737. On the theory of the ideal Bose–Einstein gas. F. KAEMPFER. *Z. Phys.*, **125** (*Nos* 4–6) 359–69 (1948) *In German.*

The phenomenon of Einstein condensation is interpreted by means of a discussion of the notion "number of particles" and values of the condensation temp. T_0 are given both for the non-relativistic and for the relativistic case. Taking the example of the cubical box, it is shown that the ideal Bose gas consisting of N particles behaves, at all temps., as a Boltzmann gas consisting of $N_B = \alpha N_{eff} = \alpha(N-N_0)$ particles, where N_0 = number of particles in the ground state and α = factor of order of magnitude 1. H. LONDON

530.162 : 536.48

738. The Bose–Einstein statistics of particles, with special reference to the case of low temperatures. R. B. DINGLE. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 2) 275–87 (1949).

Previous demonstrations of the Bose–Einstein condensation in an ideal gas are criticized and replaced by an exact treatment which gives the partition function, mean occupation numbers and a theory of fluctuations for a Bose–Einstein gas. D. SHOENBERG

530.162 : 536.48

739. Statistical mechanics and the partition of numbers. I. The transition of liquid helium. H. N. V. TEMPERLEY. *Proc. Roy. Soc. A*, 361–75 (*Nov.* 7, 1949).

The existing theory of "Bose–Einstein condensation" is compared with some results obtained from the theory of partition of numbers. Two models are examined, one in which the energy levels are all equally spaced, the other being the perfect gas model. It is concluded that orthodox theory can be relied upon at very high and at very low temps., also that the condensation phenomenon is a real one, but that it is not correctly described by orthodox theory, the position of the transition temp. and the form of the specific heat anomaly both being given wrongly. A.

530.162 : 536.75

740. On the term $k \ln n!$ in the entropy. O. STERN. *Rev. Mod. Phys.*, **21**, 534–5 (*July*, 1949).

This term appears in the classical calculation of the entropy of n atoms of a pure substance but not in the quantum derivation. Various arguments have been advanced to prove the non-existence of the term, but these are considered of doubtful validity. The quantum theory only justifies the omission of the term indirectly. It is shown that the classical and quantum calculations of the vapour pressure of a solid yield the same result provided the separate identity of the atoms in the solid state is recognized in the classical derivation. F. E. HOARE

530.162 : 538.114 : 539.22

741. Order-disorder statistics. I. C. DOMB. *Proc. Roy. Soc. A*, **196**, 36–50 (*Feb.* 22, 1949).

The partition function is derived by a method which allows the screw transformation of Kramers and Wannier [Abstr. 2412 (1947)] to be generalized and applied to a number of problems in classical statistical mechanics, including the 3-dimensional Ising model of a ferromagnetic. Distant-neighbour interactions are allowed for. The ferromagnetic and order-disorder problems are compared, and it is shown that the partition function in each case may be derived from a single function of two variables. The partition function is the largest eigenvalue of an infinite matrix of simple structure. L. S. GODDARD

530.162 : 538.114 : 539.22

742. Statistical mechanics of some co-operative phenomena. C. DOMB. *Nature, Lond.*, **163**, 775–6 (*May* 14, 1949).

The properties of a 2-dim. ferromagnetic lattice, and the theory of binary solid solutions, are discussed in detail, using the exact methods outlined earlier [Abstr. 741 (1949)]. G. J. KYNCH

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.36 : 534.015

743. The displacement-frequency characteristic of elastically coupled mechanical systems with two degrees of freedom. D. H. PEIRSON, *Proc. Phys. Soc., Lond. B*, **62**, 579–88 (*Sept.*, 1949).

Conditions are obtained for independence of deflection and frequency. The practicability of these conditions is considered and a determination made of the extent of the range for displacement independent of frequency. The relations between the fundamental constants of the systems are illustrated graphically and the application to galvanometer and accelerometer design is discussed. A.

531.51

744. Discontinuities at the wave front of gravitational action. B. FINZI. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) (*Ser.* 8) **6**, 18–25 (*Jan.*, 1949) *In Italian.*

The propagation of gravitational action is discussed and an expression for the velocity of propagation is given. Gravitational discontinuities are analysed and the equations which permit the calculation of discontinuities are solved in the general case. The analysis is carried further, in the case of discontinuities at the wave front. L. S. GODDARD

531.553

745. Solution of the differential equations of motion of a projectile in a medium of quasi-Newtonian resistance. H. POLACHEK. *Quart. Appl. Math.*, **7**, 275–91 (*Oct.*, 1949).

The history of various methods for solving the equations is reviewed. A new method and the standard method of successive approximations is used to solve the example of the trajectory of a shell with an initial velocity of 300 m/s and an angle of elevation of 60°. The ranges obtained by the 2 methods agree to within 1 m, each being 4 240 m. Variation of density with altitude is taken into account.

L. S. GODDARD

MECHANICAL MEASUREMENTS 531.7

531.714

746. A new pneumatic method for measuring small variations in length and some applications of it. C. G. HARD. *IVA, Stockholm*, **20** (*No.* 3) 107–19 (1949) *In English.*

After a brief survey of other pneumatic measuring methods the principle and theory of the Delta system are described. The device consists of two measuring chambers fed with air at constant pressure through an intermediate chamber, the air passing from the intermediate to the measuring chambers and then out into the atmosphere through valves, all mounted on the same spindle, and designed for greatest sensitivity. The relation between the ratio of the chamber to the applied constant pressure, and the spindle position, is shown to be approximately linear. The merits of the system are listed. The Delta meter, a commercial form of instrument, utilizing the Delta system, and generally used as a comparator, is fully illustrated and described. S. WEINTROUB

531.72

747. A method for estimating volume-surface ratios. H. W. CHALKLEY, J. CORNFIELD AND H. PARK. *Science*, **110**, 295–7 (*Sept.* 23, 1949).

An experimental method based on the theory of probability. N. L. JOHNSON

531.72 : 536.658.2

748. A new basis for measurement of specific surface of carbonaceous powders. R. L. BOND AND F. A. P. MAGGS. *Fuel*, **28**, 169–71 (*Aug.*, 1949).

A rapid and accurate, though comparative, assessment of specific surface is provided by the heat of wetting measurement; absolute values are obtained only if the heat liberation on wetting unit area known. It is shown that the heat liberated on wetting unit area of a non-porous carbonaceous powder substantially the same for a wide range of organ wetting liquids, and evidence is also provided which suggests that it has approx. the same value 400 ergs/cm² for several types of carbonaceou surface.

531.72 : 541.183

749. The determination of the surface area of solid from an adsorption isotherm. J. F. DUNCAN *Trans. Faraday Soc.*, **45**, 879–91 (*Sept.*, 1949).

The Harkins method, and the B.E.T. method estimating the surface area of a solid from the adsorption isotherm of a suitable gas are applied to isotherms of C_2H_4 at liquid air temp. It is shown that both methods lead to the same results for a given isotherm. The isotherm equation of Harkins, and the B.E.T. equation as modified by Anderson, are reduced to the form $p/p_0 = C[1 - V_m/(DV)]$; it shown that from the Anderson constant K, and assuming a given value for the area occupied by a adsorbed molecule, the Harkins constant k may b estimated approximately. A more accurate valu of k is obtained from the plot of p/p_0 against $1/V$ fo isotherms of N and C_2H_4. A quick method of deter mining the surface areas of large numbers of solic to about 20% accuracy is suggested, based on th assumption of a value for the Anderson constant, an the linearity of the $p/p_0 - 1/V$ plot over the range o p/p_0 from 0·25 to 0·75.

531.75

750. A method of testing bearing materials fo chemical balances. G. F. HODSMAN. *J. Sci. Instrum Phys. Ind.*, **26**, 341–2 (*Oct.*, 1949).

A method is described for comparing the wear o the centre bearings of chemical balances fitted wit different bearing materials. Results are given showin the superiority of corundum over the traditiona agate as a material for the planes of chemical balances A

531.76 : 621.317.3.029.6 : 537.22

High frequency measurement techniques. *See Abstr* 952

531.76

751. Note on the very precise measurement of time M. DELHOMME. *Ann. Franç. Chronom.* (*Sér.* 2) 3 261–8 (1949) *In French.*

Description of methods used at the Institut Géo graphique National. Two ways of measuring th period of a pendulum are described. In one a impulse derived from the pendulum gives a deflectio in a c.r.o. the time base of which is controlled by a quartz clock; in the other the impulse illuminates a engraved disc on a phonic motor driven by the clock Both methods give an accuracy of about $1 \times 10^{-}$ in 100 sec. L. ESSE

531.77

752. A tachometer. A. E. BENFIELD. *Rev. Sci Instrum.*, **20**, 663–7 (*Sept.*, 1949).

The theory and operation of a simple tachomete are described, in which a direct electrical e.m.f. i generated by attaching a magnet to the rotatin

member. It is shown how the position and orientation of the magnet affect the magnitude of the generated e.m.f., and suggestions are made for further increasing the e.m.f. generated per rate of revolution. A.

531.787.6

753. The theory of a thermal micromanometer. The case of relatively high pressures. L. DUNOYER. *C.R. Acad. Sci., Paris*, **228**, 471–3 (*Feb.* 7, 1949) *In French.*

A continuation of Abstr. 6005 (1949). The fundamental equations are applied to the case of non-zero initial pressure. An algebraical graphical method is used, and it is shown that the theoretical and experimental curves agree. An expression for the percentage error in pressure, p, corresponding to an error, $\Delta\theta$, in the wall temp. is derived, and it is concluded that, as for small pressures, the higher the filament temp. the less rigorous need be the control of the wall temp.; and that the error increases with p, being 2% for low p, but $\simeq 8\%$ for $p = 2$ mm Hg, for $\Delta\theta = 10°$. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.13

754. The viscosities of binary liquid mixtures: monofluorodichloromethane and acetone. J. R. LACHER, C. H. WALDEN AND J. D. PARK. *J. Amer. Chem. Soc.*, **71**, 3026–8 (*Sept.*, 1949).

The viscosities of binary liquid mixtures of $CHCl_2F$ and acetone have been measured for several mole fractions and over a temp. range of −80 to 0°. The results are discussed in terms of the activated complex theory of Eyring for viscous flow. A.

532.13 : 541.18

755. The statistical mechanical theory of irreversible processes in solutions of flexible macromolecules. Visco-elastic behavior. J. G. KIRKWOOD. *Rec. Trav. Chim. Pays-Bas.*, **68**, 649–60 (*Sept.–Oct.*, 1949) *In English.*

532.133

756. Viscosity of cellulose methyl ether solutions in ordinary and in heavy water. A. H. W. ATEN, JR. *Rec. Trav. Chim. Pays-Bas*, **68**, 807–16 (*Sept.–Oct.*, 1949) *In English.*

532.14.08

757. Testing of hydrometers. E. L. PEFFER AND M. G. BLAIR. *Circ. U.S. Bur. Stand.* (*No.* 477) 9 *pp.* (1949).

Discusses the design and construction of hydrometers. The various scales that are commonly used for hydrometers are defined and recommendations given for subdividing and marking them. The relations between some of the arbitrary scales and specific gravity are stated. The procedure of testing hydrometers that are submitted to the Bureau of Standards and the forms of certificates and reports issued as a result of these tests are discussed. A.

532.51

758. On the flow of a perfect fluid between two plates from a circular inlet channel. W. R. SMYTHE. Letter in *J. Appl. Phys.*, **20**, 224 (*Feb.*, 1949).

This problem has been discussed by Benedikt [see Abstr. 3790 (1949)] who derived a definite integral formula for the velocity potential, ϕ, in the case of an ideal incompressible, non-viscous fluid. Smythe derives a series expression for ϕ involving modified Bessel functions. The assumption of a uniform source, as Benedikt points out, gets rapidly worse as the distance (h) apart of the plates decreases. In the case in which $h \ll r_0$, where r_0 is the radius of the circular inlet channel, another expression can be derived for the radial velocity, which is correct to 1 part in 5 000. J. S. G. THOMAS

532.517.4

759. On the decay of isotropic turbulence. S. CHANDRASEKHAR. Letter in *Phys. Rev.*, **76**, 158 (*July* 1, 1949).

See Abstr. 6791 (1949).

532.528

760. The dynamics of cavitation bubbles. M. S. PLESSET. *J. Appl. Mech.*, **16**, 277–82 (*Sept.*, 1949).

The equation of motion for the growth and collapse of a cavitation bubble containing vapour is derived and applied to experimental observations on such bubbles. The limitations of this equation are pointed out, and include the effect of the finite rate of evaporation and condensation, and compressibility of vapour and liquid. A brief discussion of the role of "nuclei" in the liquid in the rate of formation of cavitation bubbles is also given. A.

532.59

761. Generation of surface waves by a moving partition. E. H. KENNARD. *Quart. Appl. Math.*, **7**, 303–12 (*Oct.*, 1949).

CAPILLARITY 532.6

532.61

762. Surface forces in liquids and solids. C. GURNEY. *Proc. Phys. Soc., Lond. A*, **62**, 639–48 (*Oct.*, 1949).

The author's recent treatment [Abstr. 2791 (1947)] of the forces in the surfaces of liquids is extended to the surfaces of solids and to interfaces between solids and liquids. Solid surfaces formed by cleavage at temps. such that no appreciable migration of molecules takes place, will usually be under a state of uniform stress, not necessarily tensile and not numerically equal to the free energy of the surface. If appreciable atomic migration takes place, the surface of a crystalline solid melts, and the solid is covered with a thin liquid film under a tension force $>$ that of the corresponding supercooled liquid, and such that the chemical potential of the molecules in the liquid film is equal to that of molecules in the crystal. This tension force is numerically equal to the free energy of the surface. If such a solid is subsequently cooled to a temp. at which atomic migration effectively ceases, it will have frozen in its surface a tension force corresponding to thermal equilibrium at some higher temp. The Laplace Q force is discussed in terms of modern theories of atomic bonding and applied to the case of equilibrium at angle of contact between solid and liquid. A.

532.61.08

763. An equation for the comparison of surface tensions by unstable pendant drops. K. G. PARVATIKAR. *Curr. Sci.*, **18**, 288 (*Aug.*, 1949).

Conditions are discussed under which the surface tensions of two liquid drops are related to the effective density and the equatorial diameter. Thus the ratio of tensions can be calculated if the two drops can be photographed at the unstable stage. R. A. WEALE

532.612.4

764. Surface tension of solutions of cetyl pyridinium bromide. B. K. BANERJI. *Curr. Sci.*, **18**, 292–3 (*Aug.*, 1949).

It is assumed that, in dilute solutions, the bromide molecules occupy only a fraction of the surface, which rises with concentration. On ageing, internal molecules reach the surface, but for a certain concentration equilibrium is reached quickly. The concentration at which the surface is covered and that at which micelle formation is thought to begin are given by 0·034 and 0·022% resp. These agree with data obtained by other methods. Micelle formation seems to precede the complete covering of the surface by the bromide molecules. A graph and a table are given.

R. A. WEALE

532.62

765. On the behaviour of liquid drops (and bubbles) on the surface of a solid. II. Experimental test of the formulae for the critical angle of sliding and the minimum mass of the drops (bubbles). YA. B. ARON AND YA. I. FRENKEL. *J. Exp. Theor. Phys., USSR*, **19**, 807–13 (*Sept.*, 1949) *In Russian.*

The relation between critical angle of sliding (slip) of water and Hg, and of air bubbles, on various surfaces, and their mass (dimensions) was experimentally investigated. It was shown that, independent of the wetting conditions, Frenkel's formula for the critical slip angle of the drops is satisfactorily confirmed. An analogous relation also holds for air bubbles underneath an Al surface in water. For both liquid drops and bubbles, the proposition of the existence of a certain min. mass (min. dimensions), below which there can be no sliding, was also corroborated [see Abstr. 93 (1949)]. B. F. KRAUS

MOLECULAR THEORY OF LIQUIDS 532.7

532.72

766. Some fundamental definitions and concepts in diffusion processes. G. S. HARTLEY AND J. CRANK. *Trans. Faraday Soc.*, **45**, 801–18 (*Sept.*, 1949).

The definition of a diffusion coeff. is examined critically, with particular reference to the necessity of defining clearly the section across which the rate of transfer of the diffusing substance is measured, and the units of concentration and space co-ordinate adopted. It is shown that, by suitable choice of these 3 factors, the 1-dimensional diffusion behaviour of a 2-component system can always be represented in terms of a single variable diffusion coeff. even if the partial molal volumes of the 2 components vary with composition. The relations between the diffusion coeffs. defined with respect to 3 different frames reference of practical importance are established, an several standard methods of measuring diffusio coeffs. are examined in order to see which coeff. observed in each method. Some applications of th different frames of reference are discussed. Th physical nature of a pure diffusion process is discusse in terms of random molecular motions. It is su gested that, in a binary solution, the net rate transfer of either component is the result of a transf by pure diffusion coupled with a transfer of th component due to a mass-flow of the whole solutio The mass-flow is due to the fact that, in general, th intrinsic rates of pure diffusion of the 2 componen will differ and hence there is a tendency to set up hydrostatic pressure in the solution which is relieve by a mass-flow. Reference is made to an experimenta demonstration of the mass-flow in a particular syste in which one component is a high polymer. tentative quantitative theory is proposed, incorpora ing the effect of mass-flow, and an expression for th mutual diffusion coefficient in a thermodynamicall non-ideal binary solution is derived. A

532.7

767. A new apparatus for measuring diffusion i solutions. R. B. DEAN. *J. Amer. Chem. Soc.*, **71** 3127–9 (*Sept.*, 1949).

An apparatus is described in which diffusion take place in a narrow chamber along one face of a pris into an effectively infinite volume of solvent. Th initial boundary is formed by flooding the top of th thin chamber. The concentration of diffusing materia is determined from the angle of total reflection whic is recorded photographically. The apparatus i suitable for solutions containing of the order of 1% solute. A

532.72 : 536.

768. On the thermomechanics of diffusion. J. E VERSCHAFFELT. *Bull. Acad. Roy. Belge Cl. Sci.* **35** (*No.* 4) 293–310 (1949) *In French.*

Given a fluid mixture of pure constituents whos concentrations vary from place to place, what is the energy dissipated in the flow processes which resul from this state? This question is discussed mathe matically. [See also Abstr. 217 (1949) and following Abstr.]. F. E. HOAR

532.72 : 536.

769. On thermo-electrodiffusion. J. E. VER SCHAFFELT. *Bull. Acad. Roy. Belge Cl. Sci.*, **35** (*No.* 4 311–24 (1949) *In French.*

A mathematical treatment of the diffusion of a dissolved substance under the combined influence o concentration, potential and temp. gradients to which the name thermoelectrodiffusion is given.

F. E. HOAR

532.72 : 536.

770. On the affinity of diffusion. J. E. VER SCHAFFELT. *Bull. Acad. Roy. Belge Cl. Sci.*, **35** (*No.* 6 559–67 (1949) *In French.*

A further development of the author's treatment o diffusion in which a new point of view is introduced Previous results are modified in consequence. (Se preceding Abstr.). F. E. HOAR

532.74

771. Relaxation of the enforced anisotropy in liquids. V. Tsvetkov and V. Eskin. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 263–6 (1949) *In Russian.*

The influence of viscosity on the relaxation period was investigated by the method given in Abstr. 134 (1949), in the range $6–70\times10^6$ c/s. The mean values of relaxation time were found to vary between 1·7 and $17·9\times10^{-8}$ sec for a petrol-castor oil mixture (depending on concentration) and between 1·5 and 23×10^{-8} sec for pure castor oil, depending on temp. (15–50°c). The discussion shows agreement of the acoustically determined values with those obtained by dielectric methods. B. F. KRAUS

MECHANICS OF GASES 533

533.15

772. Note on transient pressure effect in effusion. R. B. Bernstein. Letter in *J. Chem. Phys.*, **17**, 209–10 (*Feb.*, 1949).

The transient pressure changes which occur when two different gases at the same initial pressure are allowed to interdiffuse at constant temp. through an orifice < mean free path are calculated. The results are verified experimentally with good accuracy for H–N and H–A. H. LONDON

533.15

773. The diffusion-thermoeffect as a lecture experiment. K. Clusius. *Helv. Phys. Acta*, **22** (*No.* 2) 135–41 (1949) *In German.*

Description of a simple demonstration apparatus. The paper also deals with the history of this effect which was observed by Dufour in 1872. A calculation shows that the effect is not caused by deviations from the ideal gas law. H. LONDON

533.15 : 530.14

774. On the relativistic correction in some problems of diffusion. M. Draganu. *J. Phys. Radium* (*Sér.* 8) **10**, 301–4 (*Oct.*, 1949) *In French.*

Several equations occurring in diffusion theory, including the Boltzmann equation allowing for collisions, are derived in special relativity theory. G. J. KYNCH

533.15 : 536.23

775. The dependence of the thermal diffusion factor on temperature. K. E. Grew. *Proc. Phys. Soc., Lond. A*, **62**, 655–61 (*Oct.*, 1949).

The thermal diffusion factor for isotopic mixtures has been calculated from values of the collision integrals given by Hirschfelder, Bird and Spotz [Abstr. 480 (1949)] which refer to molecules exerting an inverse 13th power repulsion with an inverse 7th power attraction—the (13, 7) model. The theoretical results are compared with experimental ones for the inert gas mixtures previously considered by Grew in relation to the (9, 5) model. The agreement is, as expected, better than for the (9, 5) model. Experimental results for H–He mixtures are also given; the behaviour of these mixtures is exceptional in that the thermal diffusion factor appears to be independent of temp. over the range 12 to 600°K. A.

533.15 : 541.183.26

776. Kinetics of the absorption of carbon dioxide in water. P. V. Danckwerts. Letter in *Research, Lond.*, **2**, 494–5 (*Oct.*, 1949).

From Higbie's measurements [*Trans. Amer. Inst. Chem. Engrs*, **31**, 365 (1935)] of the rate of absorption of CO_2 in water, the best value for $K = G/G'$, where G and G' are the rates of entry of the gas molecules and of striking the interface respectively, is calculated. Taking the saturated concentration as $5·3\times10^{-5}$ gm mol/cm³, and the diffusion coeff. in the water as $1·41\times10^{-5}$ cm²/s, K is found to be 4×10^{-6}. S. WEINTROUB

533.21 : 536.71

777. Compressibility of gases at high temperatures. II. The second virial coefficient of helium in the temperature range 0°c to 600°c. W. G. Schneider and J. A. H. Duffie. *J. Chem. Phys.*, **17**, 751–4 (*Sept.*, 1949).

The coeff. was measured by an expansion procedure previously described [Abstr. 4548 (1949)]. Within limits $\simeq 0·5\%$ at 0° and $\simeq 1\%$ at 600°, the results (expressed in Amagat units of volume) are given by: $10^3B_T = 0·5485 - 0·1315\times10^{-3}T + (3·754/T)$ where T is in °K. A comparison with existing data is given. A.

533.5 : 531.788

778. Time constants for vacuum gage systems. S. A. Schaaf and R. R. Cyr. *J. Appl. Phys.*, **20**, 860–3 (*Sept.*, 1949).

A typical system for measuring pressures in a rarefied gas consists of a vacuum gauge connected to the gas by a length of tubing, usually with an orifice of dia. < that of the tubing at the end. The interior surface of this system will outgas at a fairly constant rate for a long period of time so that an equilibrium state will be reached with a definite non-constant pressure distribution along the tubing. The response time constant for the system to come to equilibrium and the difference in pressure between gas and gauge are functions of the outgassing rate and the geometry of the system. An analysis is made assuming molecular flow, and formulae are obtained for the response time and the pressure difference. It is shown that there is an optimum value of the tubing dia. for a given orifice diameter, gauge volume, and length of tubing. This optimum is rather critical; if the diameter is too small, response time constants of the order of hours may result. Experimental work has been done and the results compared with theory. A.

533.5 : 531.788.7 : 621.317.39

779. On the optimum operating conditions of a resistance type vacuum gauge. Groszkowski, J. *Kwart. Telekomun.*, **12**, 1–11 (*July*, 1949) *In Polish.*

Considers the optimum operating conditions of the resistance type conductivity vacuum gauge in the constant current circuit. Having established the principal vacuum gauge equation, i.e. "the voltage across the resistance of the vacuum gauge head *v.* the vacuum pressure," the author finds the expression for the sensitivity of the vacuum gauge as well as the conditions for the max. sensitivity as a function of the resistance wire material and wire diameter for the different pressure ranges. A.

533.6.011

780. The aerodynamics of golf balls. J. M. DAVIES. *J. Appl. Phys.*, **20**, 821–8 (*Sept.*, 1949).

The aerodynamic forces on golf balls were studied by dropping spinning balls through the horizontal wind stream of the B. F. Goodrich wind tunnel. The lift, L, and drag, D, were calculated from the drift of the balls, rotating at speeds, N, up to 8 000 r.p.m. while falling through a wind stream having a velocity of 105 ft/sec. For a standard dimple or mesh golf ball weighing 0·1 lb, the lift varied with the rotational speed as $L = 0{\cdot}064 \times [1 - \exp(-0{\cdot}00026N)]$, with a maximum observed value of 0·055 lb or more than half the weight of the ball. The drag increased nearly linearly from about 0·06 lb for no spin to about 0·1 lb at 8 000 r.p.m. For a smooth ball the lift was negative at all rotational speeds below 5 000 r.p.m. Above this speed, the lift was positive but was less than for the standard ball. The drag for these balls was nearly constant at about 0·08 lb. Balls with shallower dimples than standard gave intermediate results. Driving tests were consistent with the wind tunnel results. These results explain why a golfer cannot obtain long drives with a ball having a smooth surface and why the standard dimple or mesh surface gives him greater distance and better control of the ball. A.

533.6.011

781. On steady, laminar two-dimensional jets in compressible viscous gases far behind the slit. M. Z. KRZYWOBLOCKI. *Quart. Appl. Math.*, **7**, 313–23 (*Oct.*, 1949).

The equations of motion, continuity, energy and state are considered. The method for solving the equations of motion is outlined. The velocity and density distribution far behind the slit may be found.

L. S. GODDARD

533.6.011.31

782. Critical flow through sharp-edged orifices. J. A. PERRY, JR. *Trans. Amer. Soc. Mech. Engrs*, **71**, 757–64 (*Oct.*, 1949).

An investigation of flow rates of air through sharp-edged orifices in which the pressure drop was below the critical; the relationship of pressure, temp. and orifice area; and a comparison between the nozzle and the orifice. Equations are derived for expressing orifice flow in both the critical and subcritical regions.

A.

533.6.011.31

783. Air flow through small orifices in the viscous region. H. R. LINDEN AND D. F. OTHMER. *Trans. Amer. Soc. Mech. Engrs*, **71**, 765–72 (*Oct.*, 1949).

Experimental data for air flow through square-edged circular orifices and their correlation with the pressure difference, the orifice diameter and the air temp. are presented in nomographic form. A.

533.6.011.311 : 533.6.011.5

784. On laminar and turbulent boundary layer in supersonic flow. R. LADENBURG AND D. BERSHADER. *Rev. Mod. Phys.*, **21**, 510–15 (*July*, 1949).

A Mach–Zehnder interferometer was used to measure density variations in supersonic gas flow near a half-wedge. The wind tunnel used was of the intermittent type, giving a stream 3 × 3 in. cross-secti at Mach no. 2·4. Stagnation pressures rang between 0·8 and 3·0 atm.; the stagnation temp. v approx. 20°c. From the observed fringe-shifts density variation in the boundary layer near the face of the half-wedge can be directly deduced, a hence, assuming constant pressure across the bounda layer, the temp. variation can be calculated. Usi Crocco's theory of boundary layer structure, the loc gas-velocity is deduced from the local temp. a pressure. It is found that by far the greater part the boundary layer is supersonic. Even 0·1 m from the plate, the Mach no. is about 1·5. F Reynolds no. $(Re_x) > 2 \times 10^6$ the boundary lay along a plane surface is turbulent, and the veloc profile follows a power law similar to that for inco pressible flow. For $Re_x < 6 \times 10^5$ the velocity prof is very different, and is not far from the theoreti profile computed by Crocco for laminar bounda layers at high velocities. A. SCHOFIE

533.6.011

785. Interferometric studies of faster than sou phenomena. II. Analysis of supersonic air je R. LADENBURG, C. C. VAN VOORHIS AND J. WINCKLE *Phys. Rev.*, **76**, 662–77 (*Sept.* 1, 1949).

A study of supersonic air jets has been made by t use of the Mach interferometer. The density distrib tion in axially symmetric jets with several tan receiver pressure ratios has been determined, wi special emphasis on the 3·7–7 range of ratios. terms of the dimensionless quantities p/p_0 (ratio jet density to tank density) and Z/D (ratio of distan from orifice to orifice diameter), all jets are close the same in a region bounded by the orifice and a oblique line from the orifice edge. This line mar an inflection point in the streamlines, and probab indicates the low pressure termination of a dimensional Prandtl–Meyer expansion region whic reduces the pressure at this point below that of t receiver. The strength of the stationary shock wav in general agrees with that predicted by the Rankine Hugoniot equations. Recent theoretical computation of the density in the axis of the jets by Owen an Thornhill are in satisfactory agreement with th experimental results, but so far no suggestion ha appeared for a theory to predict the 3-shock con figuration in jets. Experiments with 2-dimensiona jets confined between parallel glass walls demon strated that the stationary 3-shock configuratio could not be studied in this way, presumably becaus of boundary layer effects on the glass which destro the 2-dimensional quality of strong shock waves [se Abstr. 2747 (1948)]. A

533.6.011.5 : 534.22

786. Shock waves in one-dimensional non-stead gas-flow. R. SAUER. *Helv. Phys. Acta*, **22** (*No.* 4 467–72 (1949) *In German.*

In a war-time report of limited circulation th author introduced the "non-stationary shock-polar which has recently been derived independently b Cap [Abstr. 3026 (1949)]. This earlier treatmen which differs from Cap's in that it is graphical rathe than numerical, is repeated in the present pape It is applied to an examination of reflection of shoc

waves from the open and the closed ends of a tube, and to the collision and coalescence of shock waves.

A. SCHOFIELD

533.6.013.22

787. The nature of turbulent motion at large wave-numbers. G. K. BATCHELOR AND A. A. TOWNSEND. *Proc. Roy. Soc. A*, **199**, 238–55 (*Oct.* 25, 1949).

533.6.071

788. The chronophotography of aerodynamic fields. J. M. BOUROT. *Publ. Sci. Min. Air, Franç.* (*No.* 226) 210 *pp.* (1949).

A comprehensive treatise on the method of representing visually an aerodynamic flow by introducing extremely finely divided bright particles (e.g. light metal flakes) and photographing them with sufficient length of exposure to show each point as a line, or vector, which gives the direction and velocity. The practical difficulties and their solutions are described, e.g. the manufacture of the ideal powder, methods of introduction into the stream, and how to get the clearest photograph. The theory is discussed, especially the error due to the particle not following the stream exactly, and a number of practical applications described, e.g. testing the turbulence or laminarity of wind tunnels, wing tip vortices, etc.

INDEX AERONAUTICUS

533.6.08

789. The theoretical background of the multiple pressure tube anemometer. P. R. GOUDY AND H. F. COLVIN III. *Rev. Sci. Instrum.*, **20**, 651–5 (*Sept.*, 1949).

A recent investigation has resulted in the development of a multiple pressure tube anemometer, which measures both wind speed and direction without moving parts exposed to the wind. From the expression for the air flow past a quadric surface, it is shown that, by the use of one system of suitably spaced impact holes, it is possible to measure the rectangular components of wind velocity in one quadrant. Another arrangement of holes is presented that takes advantage of the breakdown in flow pattern past 90° to measure wind components in all quadrants without ambiguity. The components of wind velocity so measured are combined in an electromechanical system which provides indications of speed and direction. Finally, the experimental instrument embodying these principles is evaluated and performance data taken from it are presented. A.

533.6.08 : 551.508.5

790. A vectorially integrating anemometer. A. WHITAKER. *J. Sci. Instrum. Phys. Ind.*, **26**, 377–8 (*Nov.*, 1949).

An anemometer is described which allows the integrated wind displacement in the 4 cardinal directions to be recorded directly. The instrument comprises a cup anemometer movement and a wind vane. The movement of the cups is communicated through gearing to a ball floating in Hg, and the plane of rotation of the ball is governed by the wind vane. Rotations of the ball in the 4 cardinal directions are measured by light friction wheels which transmit electrical impulses to counters. A.

533.6.08 : 551.508.5

791. An ionization anemometer. J. E. LOVELOCK AND E. M. WASILEWSKA. *J. Sci. Instrum. Phys. Ind.*, **26**, 367–70 (*Nov.*, 1949).

An anemometer is described for the measurement of air movement in the region 0–300 ft/min. The instrument is omnidirectional, rapid in response and equally sensitive over the whole range of velocities covered. A unidirectional anemometer and a flowmeter working on the same principle are also described. A.

MOLECULAR THEORY OF GASES 533.7

533.7

792. Collisions between atoms and molecules at ordinary temperatures. H. S. W. MASSEY. *Rep. Phys. Soc. Progr. Phys.*, **12**, 248–69 (1948–49).

This review is in two main sections: elastic collisions when slow relative velocities follow Maxwell's law, and collisions involving change in internal energy. Part 1 deals with transport phenomena in gases, as magnitude and temp. dependence of these coeffs. yield information concerning interaction forces between atoms; experimental determination of total collisional cross-section can also give such information. Quantum theory of collisions is outlined, and the important case of He discussed: both molecular-ray determinations of cross-sections and the measurements of the positive-ion mobilities are analysed. Part 2 discusses the exchange between electronic and translational energy in atomic collisions, and also the further effect of exchange of vibrational and rotational energy in collisions with molecules. Complete interpretation of experimental data is still not available, and further desirable investigations are indicated. F. LLEWELLYN JONES

533.7 : 530.162

Theory of ideal Bose–Einstein gas. *See Abstr.* 737

533.7 : 531.19

793. Distance correlations in an ideal Fermi–Dirac gas. P. L. BHATNAGAR AND K. S. SINGWI. *Phil. Mag.*, **40**, 917–21 (*Sept.*, 1949).

The correlations are calculated explicitly, and two probabilities, important in the theory, are calculated to a higher degree of approximation than in the original attempts of Uhlenbeck and Gropper [*Phys. Rev.*, **41**, 79 (1932)] and of Seitz [*Phys. Rev.*, **43**, 804 (1933)]. L. S. GODDARD

533.7 : 536.23 : 537.565

794. Transport phenomena in a completely ionized gas in presence of a magnetic field. R. LANDSHOFF. *Phys. Rev.*, **76**, 904–10 (*Oct.* 1, 1949).

Conduction coeffs. were calculated connecting the electric and heat currents with the electric field and the temp. gradient, which are both assumed at right angles to the magnetic field. The coeffs. are represented in a complex fashion, the real part giving a flow in the direction and the imaginary part giving a flow at right angles to the driving force. The

calculation was carried through for the nuclear charges 1, 2 and 3 and for the limit of very large nuclear charges. A.

533.75

795. Molecular distribution and equation of state of gases. J. DE BOER. *Rep. Phys. Soc. Progr. Phys.*, **12**, 305–74 (1949).

A comprehensive survey dealing with the classical and quantum theory of gases in a single logical development. Detailed proofs of the various results are not given, but the whole framework of the subject is shown. The difficulties of the justification of the statistical method are dealt with both for equilibrium states and non-equilibrium, the most recent work being included. The relationship of the work of Born and Green to the general development is reviewed. Comparisons of theoretical and experimental results are made for the second and third virial and Joule–Thomson coeffs. The calculation of the molecular pair distribution function is summarized. The concluding section deals with fluctuations, the scattering of electromagnetic waves and the evaluation of the molecular pair distribution function from X-ray analysis. Over 100 references are given.

F. E. HOARE

533.75

796. The second virial coefficients of polar gases. J. S. ROWLINSON. *Trans. Faraday Soc.*, **45**, 974–84 (*Oct.*, 1949).

An expression is calculated for the second virial coeff. of a gas composed of spherical molecules whose intermolecular potential has a repulsive term $\propto r^{-12}$, an attractive term $\propto r^{-6}$, and which have point dipoles at their centres. The method is that used by Stockmayer. A table is given for this function for suitable values of the temp. and the dipole moment. The calculated values fit the experimental results for 9 polar gases. The dipole energies of interaction and equilibrium distances of separation are calculated. The results are compared with those derived previously by an alternative treatment, using the law of mass action. In both cases, molecules that can form H bonds differ significantly from other polar molecules. A.

VIBRATIONS . ACOUSTICS 534

534.111

797. On the synchronization of a system with several degrees of freedom. J. HAAG. *C.R. Acad. Sci., Paris*, **223**, 877–9 (*Nov.* 27, 1946) *In French.*

An extension of previous work [Abstr. 119 (1949)]. The differential equations of motion are taken in canonical form, and a change of variable suggests the form of the associated system which gives the points of synchronization. Some remarks are made about particular cases and about the stability of the system, and the results are applied to some examples.

L. S. GODDARD

534.141

798. Novel methods of producing edge tones with liquids. F. L. HOPWOOD. Letter in *Nature, Lond.*, **164**, 454 (*Sept.* 10, 1949).

Two novel methods are described of producing vortex edge tones (*a*) by allowing jets of water to impinge on perforated diaphragms, and (*b*) by rotating perforated metallic discs under water. In case (*a*) the tones vary with position and angle of impact but bear no simple relation to the fundamental frequency of the loaded diaphragm. It is not necessary that the latter should be perfectly flat. In case (*b*) the rotating disc does not behave as a siren, since the notes it produces are separated by silent intervals as the speed of rotation is varied. Usually the frequency of the emitted note is higher at higher speeds, but occasionally the same note or even a lower note is produced as the speed is increased. A. B. WOOD

534.213

799. A theory of low frequency sound absorption in solids with application to soda-silica glasses. G. A. KORN. *J. Acoust. Soc. Amer.*, **21**, 547–50 (*Sept.*, 1949).

Deals with the theory of a class of relaxation mechanisms which may in part account for the absorption of sound in certain solids. The basic postulates of Eyring's theory of absolute reaction rates are applied to the development of general differential equations describing structural-chemical state changes. The macroscopic effects of transitions between the activated and unactivated states of complexes of atoms are discussed, and the results are applied to the problem of sound absorption and mechanical relaxation due to structural-chemical changes in soda-silica glasses. It appears that the transition of alkali ions from holes in the glass lattice into the interstitial space, as in electrolytic conduction, is associated with the acquisition of a certain activation energy, so that the transition probabilities are finite. The process is thus of the nature of a relaxation mechanism which is capable of causing sound absorption. The functional dependence of absorption on frequency predicted by the theory and the predicted functional dependence of the relaxation time on temp. are found to agree with experimental results. A.

534.213.4

800. On the propagation of sound waves in narrow conduits. O. K. MAWARDI. *J. Acoust. Soc. Amer.*, **21**, 482–6 (*Sept.*, 1949).

The analysis of the propagation of sound waves in narrow tubes has usually been restricted to shapes yielding tractable mathematical expressions. A great number of practical applications do not fall within these categories and await a solution. An approximate solution of sufficient accuracy for narrow tubes of arbitrary shapes developed in this paper has been applied to a wire-filled tube. The theoretical predictions agree satisfactorily with the experimental results. A.

534.22

801. Applications of the impulse method to physical problems. R. ADOLPH AND H. O. KNESER. *Z. angew. Phys.*, **1**, 382–7 (*May*, 1949) *In German.*

A survey is given of the applications of pulse

techniques to the measurement of the velocity and absorption of sound waves in solids, liquids and gases. In solids, an echo-sounding technique is used for flaw detection, employing ultrasonic waves of frequency 5 Mc/s. Absorption measurements are made on solids, using ultrasonic frequencies, to develop materials suitable for delay lines and to study the heating effect of ultrasonic vibrations. Very accurate measurements can be made by the echo technique to determine the velocity of ultrasonic waves in liquids. It has been found with liquids that the absorption increases with the square of the frequency, so that some materials become almost impermeable to sound at very high frequencies. The troposphere is studied by echo-sounding with the impulse technique using frequencies of 1–4 kc/s. A. C. WHIFFIN

534.22 : 539.321.9

802. The absorption and dispersion of ultrasonic waves in acetic acid. J. LAMB AND J. M. M. PINKERTON. *Proc. Roy. Soc. A*, **199**, 114–30 (*Oct.* 7, 1949).

Gives the results of measurements of the absorption and velocity of propagation of ultrasonic waves in acetic acid over the frequency range 0·5 to 67·5 Mc/s and at temps. from 16 to 60°C. It is shown that a dispersion and a max. in the value of absorption per wavelength occur, and the results confirm the existence of a relaxation process arising from the perturbation of a molecular equilibrium by the ultrasonic vibrations. The results are discussed in the light of existing theory, and in particular the activation energy of the process is obtained from the measured variation of relaxation time with temp. It is suggested that the relaxation mechanism is possibly connected with a perturbation of the equilibrium between single and double molecules of acetic acid. The results also indicate the existence of a further relaxation process giving a second max. in the absorption per wavelength at some frequency $> 67{\cdot}5$ Mc/s. A.

534.23

803. Transmission of waves through circular apertures. A. STORRUSTE. *K. Norske Vidensk. Selsk. Forh.*, **21**, 84–7 (1948) *In English.*

A mathematical paper dealing with the transmission of a plane wave of sound through a hole in an infinite rigid screen. Values of the transmission coeff. (ratio of incident to transmitted energy) are derived in terms of the wavelength of sound relative to the radius of the hole. Polar diagrams are given for the distribution of waves transmitted through a circular hole, for various values of wavelength.

A. B. WOOD

534.231

804. An interference paradox in sound. A. MOLES. Letter in *Nature, Lond.*, **164**, 487 (*Sept.* 17, 1949).

Explains why two violins played together in a room always sound louder than one, in apparent contradiction to the laws of interference.

A. B. WOOD

534.231

805. Bjerknes forces in stationary sound fields. F. G. BLAKE, JR. Letter in *J. Acoust. Soc. Amer.*, **21**, 551 (*Sept.*, 1949).

Reference is made to the localization of bubbles at "the nodes" of an intense acoustic standing wave system in a "gassy" liquid. These nodes have been recently identified as "pressure" rather than "velocity" nodes. The author has observed also extremely small bubbles at the pressure antinodes from whence they migrate. The motions of the bubbles have been attributed to a type of Bjerknes force—the mutual reaction between pulsating bodies in a liquid, attractive if the oscillations are in phase, repulsive if out of phase. If two bubbles are one larger and one smaller than the resonant size they oscillate out of phase and repel each other; if both are larger or both smaller than the resonant size their pulsations are in phase and they attract each other. At a pressure of 1 atm. and a frequency 60 kc/s the radius of a resonant bubble is 0·005 cm.

A. B. WOOD

534.232

806. Theoretical aspects of the reciprocity calibration of electromechanical transducers. S. P. THOMPSON. *J. Acoust. Soc. Amer.*, **21**, 538–42 (*Sept.*, 1949).

A unified theory of the reciprocity calibration of electromechanical transducers is presented in a form which facilitates the derivation of particular calibration theories. The theories of two types of calibration procedure are treated as special cases. One of the theories is shown to reduce, when lumped standards are used, to that of the original technique of Trent; the other is descriptive of a new procedure. The application of calibration theories is discussed—particular attention being devoted to the use of distributed-constant standards and the consequent difficulties involved. A.

534.232 : 621.395.61

807. On the reciprocity free-field calibration of microphones. W. WATHEN-DUNN. *J. Acoust. Soc. Amer.*, **21**, 542–6 (*Sept.*, 1949).

The physical conditions for a valid reciprocity free-field calibration are examined in detail. The expression for the absolute value of the reciprocity parameter J is derived in a general manner. The result shows that J is actually a transfer admittance relating the volume current Q of the linear, reversible transducer to the pressure P this unit causes at a certain point in space. The usefulness of this concept in other than free-field conditions is pointed out. The formula for the sensitivity of the unknown microphone is derived by a method which emphasizes the significance of the physical arrangement, and the limiting conditions are stated. Practical methods for determining the validity of the calibration are suggested. A.

534.232 : 534.321.9

808. Ultrasonic radiation from curved quartz crystals. L. FEIN. *J. Acoust. Soc. Amer.*, **21**, 511–16 (*Sept.*, 1949).

From transmitting frequency responses in water, admittance measurements in air and water, and radiation patterns in water, calculations were made of the electro-acoustic efficiencies at 1 250 kc/s of 4 one-inch square X-cut quartz crystals of practically equal thickness having radii of curvature of ∞, 25, 7 and 4 cm, respectively. Efficiency values calculated from acoustic measurements do not check as well

with the calculated potential efficiencies as do those calculated from admittance measurements. The latter values indicate that the radiation resistance is the same for the four crystals. Focusing measurements show agreement with Williams's prediction that the point of max. acoustic intensity in the radiation pattern is not necessarily at the centre of curvature of the crystal. Resonance frequencies obtained from admittance measurements in air make plausible the deduction that the effective mass of a crystal decreases with increasing curvature. A.

534.25

809. Refracting sound waves. W. E. KOCK AND F. K. HARVEY. *J. Acoust. Soc. Amer.*, **21**, 471–81 (*Sept.*, 1949).

Structures are described which refract and focus sound waves. They are similar in principle to certain recently developed electromagnetic wave lenses in that they consist of arrays of obstacles which are small compared to the wavelength. These obstacles increase the effective density of the medium and thus effect a reduced propagation velocity of sound waves passing through the array. This reduced velocity is synonymous with refractive power so that lenses and prisms can be designed. When the obstacles $\simeq \lambda/2$ in size, the refractive index varies with wavelength and prisms then cause a dispersion of the waves (sound spectrum analyser). Path length delay type lenses for focusing sound waves are also described. A diverging lens is discussed which produces a more uniform angular distribution of high frequencies from a loud speaker. A.

534.25

810. The compensation method of measuring acoustic double refraction of liquids. V. TSVETKOV AND V. MARININ. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 6) 653–6 (1948) *In Russian.*

The acoustic birefringence occurring in a viscous liquid placed into a homogeneous ultrasonic field is, in the simplest case, a harmonic function of the co-ordinates and time. When observing the liquid in non-modulated light, the birefringency changes its sign ω/π times per sec and thus cannot be compensated by the usual types of compensators (wedge or elliptic compensators). Methods are given for measuring the r.m.s. value Δn from the intensity of light passing a system polarizer-object-analyser (in principle, a polarizing photometer). The method presented permits of a direct compensation and thus of measuring the magnitude of the effect in any point of the field. It is based on the use of a beam of light modulated by a Kerr cell supplied by the same generator as the piezo-quartz producing the acoustic field. Measurements in castor and sunflower oil show excellent agreement with the theoretically predicted linear dependence of the effect on the voltage applied to the quartz. B. F. KRAUS

534.26

811. On two complementary diffraction problems. A. STORRUSTE AND H. WERGELAND. *K. Norske Vidensk. Selsk. Forh.*, **21**, 38–42 *and* 43–8 (1948) *In English.*

Two mathematical papers dealing with (1) circular hole and disc in confocal co-ordinates, and (2) transmission of sound through a circular hole. The problem has been dealt with previously (*a*) by Rayleigh for long wavelengths (compared with the dia. of hole or disc), and (*b*) by Casimir for short wavelengths. In order to cover the intermediate case of wavelengths comparable with the hole or disc dia., the authors have worked out an exact solution. A curve is given showing the variation of the transmission coeff. S/S_0 through a circular hole as a function of $2\pi a/\lambda$ (where a is the radius of the hole and λ the wavelength). S/S_0 approaches unity when $2\pi a/\lambda > 4$. A. B. WOOD

534.266

812. Scattering of waves by circular discs. A. STORRUSTE. *K. Norske Vidensk. Selsk. Forh.*, **21**, 88–91 (1948) *In English.*

A mathematical paper dealing with the diffraction of waves round a circular disc—using spheroidal functions defined in an earlier paper [Abstr. 803 (1950)]. Polar diagrams are given for the distribution of waves scattered by a circular disc of radius a for various values of wavelength λ. Curves are also given comparing the relative scattered energy in the case of a plane wave impinging on a disc, and the transmission coeff. for the corresponding problem of a circular hole in an infinite rigid screen. A. B. WOOD

534.26

813. Erratum: On diffraction through a circular aperture. J. W. MILES. *J. Acoust. Soc. Amer.*, **21**, 434 (*July*, 1949).

See Abstr. 6040 (1949).

534.321.9 : 548.5

The effect of ultrasonics on the formation of metal crystals by electrolytic deposition. *See Abstr.* 1338

534.441.2

814. The cathode-ray sound spectroscope. R. C. MATHES, A. C. NORWINE AND K. H. DAVIS. *J. Acoust. Soc. Amer.*, **21**, 527–37 (*Sept.*, 1949).

This device provides for rapid analysis of short samples of speech and other sounds. It permits direct viewing of the energy-frequency distribution of the sound at instants of time in a 2-dimensional pattern, and also over intervals of time as a 3-dimensional pattern. Magnetically recorded on a disc at slow speed, and speeded up 200 times on playback, the sample of sound is analysed rapidly by a broad band high frequency system. The 3-dimensional portrayal (in time, frequency and amplitude) shows the whole sound sample, including an interval of about $\frac{1}{2}$ sec, on one c.r.t., together with a movable indication of the point in time at which the "instantaneous" or 2-dimensional frequency-amplitude section, appearing on another tube, is taken. This 2-dimensional pattern displays amplitude on a decibel scale and covers about a 40 db range. The complete pattern is made up of 190 amplitude values for the 100 to 4 000 c/s frequency range so that the pattern is formed by 190 vertical lines. The effective band width of the resolving filter is 45 c/s. The patterns are scanned at a rate of 2/sec so that a slow phosphor screen is used for viewing. Successive sections approximately $2\frac{1}{2}$, 5, 10, 20 or 40 msec apart may be established and photographed automatically.

For direct viewing manual selection of any desired point of analysis is provided. A.

534.7

815. Some determinants of interaural phase effects. L. J. HIRSH AND F. A. WEBSTER. *J. Acoust. Soc. Amer.*, **21**, 496–501 (*Sept.*, 1949).

An attempt to determine what characteristics a masking sound ("masker") must have if it is to produce interaural phase effects. A 250 c/s tone was presented against 4 different kinds of background. The masking sounds were (1) pure tones, (2) regular pulses (125 per sec), (3) random pulses (average 125 per sec) and (4) random noise. Combinations of filters permitted the presentation of these maskers in frequency bands that were varied in width and centre frequency. The results indicate that the threshold for the tone in the presence of a regular, periodic masker does not depend to any significant degree upon interaural phase relations. A necessary characteristic of the masker that produces interaural phase effects is randomness or irregularity. Both masking and the interaural phase effects increase as the frequency band of a random masker approaches the frequency of the tone. Bandwidth alone does not contribute to the interaural phase effects except as widening a band tends to bring one cut-off nearer the frequency of the tone. Wide and narrow band maskers, both of which contain the frequency of the tone, produce the same effects. A.

534.78

816. Extraction and portrayal of pitch of speech sounds. O. O. GRUENZ, JR. AND L. O. SCHOTT. *J. Acoust. Soc. Amer.*, **21**, 487–95 (*Sept.*, 1949).

An improved method for automatically extracting the pitch information of speech sounds has been devised. It employs a combination of gain control, double detection, voiced sound selection, unvoiced sound exclusion, and a means for counting the fundamental vibrations in the voiced sound intervals. Reliable indications of pitch have been obtained over a range corresponding to frequencies from 100 to 600 c/s for a wide variety of voices. The pitch-indicating signals have been applied, for study purposes, to a number of visual portrayal means for showing pitch changes, and descriptions of several of these systems are included. A.

534.83 : 537.3

817. Graphical representation of a continuous noise spectrum. D. WALKER. Letter in *Proc. Phys. Soc., Lond. B*, **62**, 530 (*Aug.*, 1949).

The advantage of plotting $dE/d(\log f)$ rather than dE/df are pointed out. A. H. W. BECK

534.84

818. Determination of an intelligibility index for speech in rooms. J. PUJOLLE. *Ann. Télécommun.*, **26**, 325–8 (*Aug.–Sept.*, 1949) *In French.*

In addition to the usual reverberation measurements in large halls, it is often necessary to determine the precision with which articulate sounds can be understood. The compilation of suitable lists of consonant and vowel sounds based on their frequency of recurrence in the language is discussed and the results of tests made in two halls are described. G. F. HODSMAN

534.86 : 621.395.623.7 : 621.396.62

819. The problem of electroacoustics of radio receivers. V. K. IOFE. *Radiotekhnika*, **4**, 69–72 (*May–June*, 1949) *In Russian.*

A criticism of Govyadinov's paper on the subject [Abstr. 4589 (1949)], containing corrections of his formulae. It is shown that it is not permissible to omit the moving air mass from the sum of moving components of a speaker, and that it is necessary to consider the effects of perforated and elastic back panels of speaker cabinets. A. LANDMAN (R)

OPTICS . RADIATION . SPECTRA 535

535.222 : 538.566 : 621.396.11

820. Can the velocity of propagation of radio waves be measured by Shoran? C. I. ASLAKSON. *Trans. Amer. Geophys. Un.*, **30**, 475–87 (*Aug.*, 1949).

The velocity of light and the velocity of propagation of radio waves are theoretically identical in vacuo. With refined methods of utilizing radar, long distances can be measured with accuracy. This paper describes the methods used to measure 47 lines varying in length from 67 to 367 miles. Six of the lines measured could be compared with geodetic distances obtained from first-order triangulation. The entire network of lines was so designed that a rigid adjustment could be made. From the comparison with the 6 geodetic lengths and from an adjustment of the 41 other lines, a value of the velocity of propagation of radio waves in vacuo is deduced which exceeds by 16 km/s the Anderson value of velocity of light in vacuo of 299 776 km/s. All sources of error are discussed. A.

535.23.08 : 621.396.621.5 : 621.317.382.029.6

821. Conditions of maximum sensitivity of u.h.f. radiometers. J. L. STEINBERG. *Onde Elect.*, **29**, 160–6 (*April*, 1949) *In French.*

The radiometers considered are of the type described by Dicke [Abstr. 81 (1947)], designed specially for measuring the apparent temp. of sources by means of their u.h.f. emission. Maximum sensitivity depends on the noise factor and the input bandwidth. With the best circuit arrangements it should be possible to measure apparent temp. to within about 0·3°. A radiometer using a dipole, with reflector, at the focus of a parabolic mirror 3 m in dia. and operating on a frequency of 1 200 Mc/s, has been constructed at the physics laboratory of l'École Normale Supérieure for the study of solar radiation. The superheterodyne receiver, with symmetrical input circuit, has a h.f. bandwidth of 20 Mc/s and a noise factor of 3·5. Preliminary records obtained with this equipment indicate a solar apparent temp. of 100 000°K. Further details of the equipment will be published later. A. WILKINSON (R)

535.24

822. Measurement of radiation falling on a flat surface. E. R. COOPER AND M. C. PROBINE. *J. Sci. Instrum. Phys. Ind.*, **26**, 348–50 (*Oct.*, 1949).

A method is described of sampling the total radiant flux falling from a variety of directions on a flat

surface and enabling a spectrometer to be used to analyse the sample. A.

535.247

823. A light-time integrator. T. B. DAVENPORT. *J. Sci. Instrum. Phys. Ind.*, **26**, 305–6 (*Sept.*, 1949).

A simple and compact electronic circuit, employing a vacuum photocell as the light-sensitive element, is described. By the use of this circuit, and provided that the energy distribution of the source remains invariant, the amounts of radiant energy emitted by a given light source over differing periods of time may be directly compared, provided that the energy distribution of the source remains invariant. If required, and, of course, provided that the photocell employed is sensitive to the radiation, the instrument may be calibrated to measure in absolute units the total monochromatic radiant energy falling on the receiver in any given period of time. It is suggested that the circuit may prove useful for monitoring light sources in photochemical work. A.

535.31

824. The contributions of Thomas Young to geometrical optics, and their application to present-day questions. T. SMITH. *Proc. Phys. Soc., Lond. B*, **62**, 619–29 (*Oct.*, 1949).

Thomas Young's constructions for primary and secondary conjugate foci are described, and his algebraic equations are given. The latter are put into the form found most convenient when an instrument of several surfaces is considered. The special forms of these equations referred to the centres of curvature of the reflecting or refracting surfaces are used to show that in spherically symmetrical instruments the number of degrees of freedom—which is equal to the number of surfaces when these are spherical—must exceed the number of aberrations that can be corrected. It is concluded that non-spherical surfaces are likely to be very important or perhaps essential for any marked improvement in the correction of optical instruments, and that Young's equations, which relate expressly to spherical surfaces, may prove less useful in the future than they have been in the past. A.

535.31

825. A new check formula for the trigonometric tracing of meridian rays, and its application in the calculation of sagittal pencils. A. CLEMENTI. *Rev. Opt. (Théor. Instrum.)* **28**, 533–6 (*Oct.*, 1949) *In French.*

The formula is given in two parts, the first of which is identical with Conrady's 3–6–9 check for the logarithms: the second part checks the rest of the calculation. This latter gives directly the factor $\sin(\omega - \omega^1)/\sin\omega \sin\omega$ ($\omega_1\omega^1$ = convergence angles), which is required in Lange's form of the sagittal equations. H. H. HOPKINS

535.317

826. The theory of the microscope. IV. The boundary-wave theory of image formation. L. C. MARTIN. *Proc. Phys. Soc., Lond. B*, **62**, 713–25 (*Oct.*, 1949).

The theory of boundary waves (Young, Rubinowicz and others) is developed for the 2-dimensional case and applied to discuss image formation for sma apertures, obstacles and phase-retarding lamina The theoretical predictions are illustrated by diffra tion photographs.

535.317.2

827. The influence of magnification on resolvin power of telescopic systems for Foucault test object of different inherent contrast. H. S. COLEMAN M. F. COLEMAN AND S. W. HARDING. *J. Opt. Soc Amer.*, **39**, 771–4 (*Sept.*, 1949).

The results of the study indicate the existence of a optimum magnification that can be used to resolv Foucault test objects and that this value depend upon the inherent contrast of the test object. A the test object contrast decreases, the optimun amount of magnification decreases. For test object having an inherent contrast $\simeq$ 100%, an optimun amount of magnification $\simeq 70\times$ for each 25·4 mm of aperture of the telescopic system under con sideration. For objects of 10% inherent contrast the optimum magnification $\simeq 30\times$ for each 25·4 mm of aperture. A

535.317.

828. Wave-front aberrations of oblique pencils in symmetrical optical system: refraction and transfe formulae. W. WEINSTEIN. *Proc. Phys. Soc., Lond. B* **62**, 726–40 (*Oct.*, 1949).

The wave-front aberrations which occur in a penci traversing a symmetrical optical system at a finite field angle are defined in a new way. Refraction and transfer formulae are derived for all the aberration coeffs. up to and including those depending on the fourth power of the aperture of the pencil. A

535.317.

829. The aberrations of slightly decentered optica systems. L. I. EPSTEIN. *J. Opt. Soc. Amer.*, **39** 847–53 (*Oct.*, 1949).

Two separate cases of aberrations due to decentra tion are discussed: In one, the field of view is small and the aperture and spherical aberration are finite In the other, the aperture is small, and the field o view, astigmatism, curvature of field, and distortion are finite. In either case, only small decentrations and tilts are admitted, and small quantities of order higher than the first are neglected. Since each member of the decentered system is itself a coaxial system, skew rays may be traced through each member with the aid of the laws of orthogonal systems. It is found that decentrations in a wide-aperture system give rise to coma, whereas in a wide-field system they give rise to a kind of distortion. A numerical example of each is given, and the resulting aberrations are compared to their third-order approximations. A.

535.318

830. A new series of microscope objectives. I. Catadioptric Newtonian systems. D. S. GREY AND P. H. LEE. *J. Opt. Soc. Amer.*, **39**, 719–23 (*Sept.*, 1949).

The problem of computing a microscope objective corrected for visible and u.v. light is reviewed. As it does not seem possible to achieve freedom from chromatic aberrations over this interval with purely refractive objectives of large numerical apertures, a

tudy of catadioptric objectives limited to spherical urfaces is initiated. Catadioptric objectives containing 2 mirror surfaces may be described as deriving rom either the Newtonian or the Schwarzschild elescope objective. Construction data are given for Newtonian objectives which have numerical aperture ·0 and which are corrected from 220 mμ through he visible spectrum. These modified Newtonian bjectives have one serious defect: a large central portion of the aperture is obscured. A.

535.322.5

831. Use of polytrifluorochloroethylene in infra-red and Raman spectroscopy. J. S. KIRBY-SMITH AND E. A. JONES. *J. Opt. Soc. Amer.*, **39**, 780–1 (*Sept.*, 1949).

Methods of fabricating Raman scattering tubes and infrared absorption cells of chemically resistant polytrifluorochloroethylene are described. Curves showing the infrared transmission of the material are given. Approximate values for the visible and ultraviolet transmission are also included. A.

535.325

832. The influence of pressure on refractive index and deformation of molecules in gases. S. R. DE GROOT. *Rev. Opt. (Théor. Instrum.)* **28**, 627–34 (*Nov.*, 1949) *In French.*

Earlier measurements of refractive index (n) for C_2H_4 and N_2 for pressures up to 2 500 atm. [Abstr. 3111 (1947)] and of the permittivities (ε) of CO_2 up to 1 700 atm. [Abstr. 3407 (1939)] show that the functions $(n^2 - 1)/(n^2 + 2)\rho$ and $(\varepsilon - 1)/(\varepsilon + 2)\rho$ first increase and then decrease with increasing pressures. The maximum can be explained by the effect of intermolecular forces [Bottcher, *Physica*, **9**, 945 (1942)]. The results are also correlated with earlier calculations [Abstr. 2617 (1947)] of the effect of pressure on the energy levels of H.

G. F. LOTHIAN

535.325

833. Refractive indices of water vapor and carbon dioxide at low pressure. K. B. NEWBOUND. *J. Opt. Soc. Amer.*, **39**, 835–40 (*Oct.*, 1949).

The Fabry–Perot interferometer has been used to obtain the dispersion curves for water vapour and for CO_2 in the wavelength range 2 500 Å to 8 600 Å at pressures below 20 mm of Hg and at a temp. of 20°C. The results have been formulated to permit computation of the refractive index of air containing these substances. The presence of water vapour in air used for precision wavelength measurements is undesirable, due to possible formation of an adsorbed film of water on the etalon mirrors. This has been observed for evaporated Al/Ag mirrors. Temp. variation causes the effective thickness of the common form of Fabry–Perot etalon to vary in much greater degree than is predicted by the expansion coeff. of the spacer material. The explanation of this effect leads to the conclusion that the etalon pressure coeffs. will show similar anomalies. It is possible to explain qualitatively the discrepancies between the measurements of the refractive index of air made by Meggers and Peters [*Bull. Bur. Stand.*, **327**, 697 (1918)] and those by more recent observers. A.

535.33.03 : 536.46

834. A new technique for the spectroscopic examination of flames at normal pressures. H. G. WOLFHARD AND W. G. PARKER. *Proc. Phys. Soc., Lond. A*, **62**, 722–30 (*Nov.*, 1949).

Up to the present spectroscopic studies of flames supported on a tube have been limited by the geometry of the flame. Thus the important reaction zone presents a 3-dimensional problem in which it is impossible to locate the emitters exactly. Moreover this zone is so thin in premixed gas flames that intermediate products cannot be determined from absorption studies. To overcome these difficulties the authors have constructed a burner with a 2-dimensional diffusion flame in which the reaction zone at ordinary pressures is 5–10 mm thick and has an optical depth of 5 cm or more. With this flame many of the reacting molecules can be located through either their emission or absorption spectra or both. The value of the new technique in the elucidation of combustion processes is demonstrated with reference to NH_3–O_2 and H_2–O_2 flames, and mention is made of its application to hydrocarbon flames. A.

535.33.072

835. Installation and use of a double-beam recording infra-red spectrometer. J. L. HALES. *J. Sci. Instrum. Phys. Ind.*, **26**, 359–65 (*Nov.*, 1949).

The advantages of using a double-beam system are examined. An improved double-beam recording infrared spectrometer is described and various problems attendant on the setting up and routine operation of a spectrometer of this type, with its double d.c. galvanometer-photocell amplifier and potentiometric recorder, are reviewed in detail. These include causes of instability in the amplifiers, the instrumental limitations of this type of double-beam instrument, and the effect of various factors on the elimination of spectral absorption by atmospheric water vapour and CO_2. A.

535.331

836. Wavefunctions and oscillator strengths for the continuum at the head of series in the spectra of Mg II and Si II. L. BIERMANN AND K. LÜBECK. *Z. Astrophys.*, **26** (*No.* 1) 43–50 (1949) *In German.*

Description of the method used for the extensive calculations of continuous wavefunctions and of the corresponding transition probabilities for the ions of Mg II and Si II, carried out at the Observatories at Berlin–Babelsberg and Hamburg–Bergedorf.

A. BEER

535.331 : 523.87

837. Measurement of *f*-values in the iron spectrum with applications to solar and stellar atmospheres. W. W. CARTER. *Phys. Rev.*, **76**, 962–6 (*Oct.*, 1949).

The relative *f*-values of 47 spectral lines of Fe I have been derived from measurements of intensities in emission of lines excited in an electric furnace. The measurements were made photoelectrically. The *f*-values were measured relative to King's previously determined values and are on the same scale. Lines with excitation potential of low term up to 3·5 V are included. The *f*-values derived have been used to plot a solar curve of growth. The scatter of the points for high energy level lines is large.

This is due mainly to the fact that lines whose low term is of odd parity are apparently consistently too strong in the sun and those of even parity too weak. On the other hand curves of growth for the giant stars γ-Cygni and α-Persei exhibit a much smaller scatter of points and no evidence of odd-even difference. Measurements of laboratory pressure shifts show systematic odd-even differences. These tests indicate that the effect observed in the sun is real and suggests that it may be due to the relatively high pressure in the solar atmosphere. If this is true the practice of using relative f-values derived from the solar curve of growth in the study of stellar atmospheres should be reconsidered. A.

535.333

838. A note on the infra-red spectra of the deutero-ammonias. J. S. BURGESS. Letter in *Phys. Rev.*, **76,** 1267 (*Oct.* 15, 1949).

High resolution data have been obtained for the regions 790–1 800 cm^{-1} and 2 350–2 600 cm^{-1} and several Q-branches observed. An attempt is made to assign these branches by comparison with calculated frequencies. A. HARVEY

535.337

839. The optical detection of radiofrequency resonance. F. BITTER. *Phys. Rev.*, **76,** 833–5 (*Sept.* 15, 1949).

Calculations are made of the frequency, intensity, and polarization of the light emitted by an atom in a ^2P–^2S transition in a weak magnetic field having an oscillating component. Near resonance, or when the frequency of the oscillating component approaches the Larmor frequency of one of the two states involved in the radiation process, all of the quantities calculated are modified. Qualitatively similar results are to be expected for other transitions. Observations in very weak fields would be of particular interest because they would give information on nuclear spins as well as atomic g-factors. Under such conditions, the Zeemann components will in general not be resolvable. There will, however, be a change in the polarization of the edges of a spectral line at resonance. It is shown that very small changes in this polarization structure are theoretically detectable. A.

535.338

840. The Deslandres–D'Azambuja band system of the C_2 molecule in the ethylene-oxygen flame. G. A. HORNBECK AND R. C. HERMAN. Letter in *J. Chem. Phys.*, **17,** 842 (*Sept.*, 1949).

This band system, observed previously in both condensed and uncondensed discharges, is now reported as a prominent feature of both the C_2H_4–O and CH_4–O flames. A. HARVEY

535.338 : 536.46

841. Spectroscopic studies of low-pressure flames. II. Effective translational and rotational temperatures from CH bands. A. G. GAYDON AND H. G. WOLFHARD. *Proc. Roy. Soc. A*, **199,** 89–104 (*Oct.* 7, 1949).

Using a Fabry–Pérot interferometer, the Doppler widths of lines of the CH bands emitted from the reaction zone of an oxy-acetylene flame have been examined. The experimental arrangement and method of computation are described. The effective translational temp. of the excited CH radicals are around 4 000°K in the low-pressure flames, compared with theoretical max. flame temps. around 2 700°K. At atmospheric pressure the translational temp. is near the expected flame temp. The effective rotational temps. have also been measured for the CH bands 4 315 and 3 900 Å and do not differ much from the theoretical max. flame temps. for any of the several flames examined. The method of excitation of the CH is discussed. It seems likely that the radicals are excited by collision with other active species in the flame; the high translational temp. shows that one is not dealing with normal thermal excitation but there are also difficulties in attributing the effects to true chemiluminescence. For the weak CH band at 3 143 Å the effective rotational temp. is very high, especially at low pressure. [See Abstr. 2445 (1948)]. A.

535.338.33

842. Hyperfine structure of 4^3P–4^3D of the spectrum of Al II. S. SUWA. Letter in *Phys. Rev.*, **76,** 847 (*Sept.* 15, 1949).

Work on the lines $\lambda\lambda$6243, 6231 and 6226 is reported. Their structure is unusual because the multiplet separations are of the same order as the hyperfine splittings. R. F. BARROW

535.338.333

843. On the isotopic displacement in the spectrum of samarium. P. BRIX AND H. KOPFERMANN. *Z. Phys.*, **126** (*Nos* 3–4) 344–64 (1949) *In German.*

Lines in the spectral region 4 300–7 200 Å were examined with a Fabry–Pérot interferometer, and accurate photometric measurements were made on 5 prominent lines. The odd Sm isotopes (147 and 149) have spin $\geqslant 3/2$. The large displacement between the Sm^{150}- and Sm^{152}-lines is anomalous, and is connected with the sudden change in nuclear quadrupole moment around these mass-numbers observed for nearby elements. A simple nuclear model is discussed, which accounts qualitatively for the order of magnitude of the observed effect. L. PINCHERLE

535.338.334

844. Pressure broadening in the microwave and infra-red regions. P. W. ANDERSON. *Phys. Rev.*, **76,** 647–61 (*Sept.* 1, 1949).

A generalized theory of collision broadening is developed, adequate for predicting line breadths in the microwave and infrared regions. This theory differs from previous ones in taking into account transitions among quantum states caused by collisions, although it is limited to a classical picture of the relative motion of the colliding molecules as a whole. Formulae are derived for computing approximate line-broadening collision cross-sections from known intermolecular interactions, and the results of the theory are successfully compared with experiments on self-broadening in the NH_3 inversion spectrum and the vibrational band spectra of HCl and HCN. Some cases of foreign gas broadening in the microwave region are examined, but it is concluded that in general the van der Waals' interaction, commonly assumed to be the force important in causing foreign gas broadening, is not adequate to cause the observed broadenings. The more complicated types of forces which become important at short range would have

to be taken into account to give good agreement with experiment in these cases. A.

535.338.4

845. An infra-red band system of SrO. G. ALMKVIST AND A. LAGERQVIST. Letter in *Nature, Lond.*, **164**, 665 (*Oct.* 15, 1949).

Rotational and vibrational analyses show that the transition is $^1\Sigma - {}^1\Sigma$ with the same final level as the blue system. Molecular constants are given. The vibrational assignments differ from those of Mahla, the band at 9 195·82 Å being the (0, 0). A. G. GAYDON

535.338.4

846. The emission spectrum of sodium vapour at low pressures in an atmosphere of xenon. R. AYNARD AND L. HERMAN. *C.R. Acad. Sci., Paris*, **228**, 995–7 (*March* 21, 1949) *In French.*

535.338.4

847. Red bands of MgO. A. LAGERQVIST AND U. UHLER. Letter in *Nature, Lond.*, **164**, 665–6 (*Oct.* 15, 1949).

The transition is $^1\Sigma - {}^1\Pi$ not $^1\Sigma - {}^1\Sigma$ as reported by Mahanti. The upper level is the same as that of the green system. Rotational constants are given.

A. G. GAYDON

535.338.4 : 536.52

848. Spectroscopic method of measuring temperature, using incompletely resolved bands. J. JANIN AND C. EYRAUD. *Rev. Opt. (Théor. Instrum.)* **28**, 612–20 (*Nov.*, 1949) *In French.*

Energy distributions in the N_2 bands at $\lambda = 4\,059$ Å and 3 914 Å are calculated to give the envelopes of intensity obtained with incomplete resolution, for temps. in the range 800°–3 200°K. The results are used to determine the temps. in a low intensity arc in air between Pt electrodes. The sensitivity is found to be 50° and 100° at 1 000° and 2 500°K respectively.

G. F. LOTHIAN

535.338.4 : 539.133

849. The emission spectra of gaseous H_2O and D_2O as excited by electron collision. S. LEACH. *C.R. Acad. Sci., Paris*, **228**, 1006–7 (*March* 21, 1949) *In French.*

Bands in the visible region are analysed vibrationally, and in part rotationally. [Compare Schüler and Wœldike, *Phys. Z.*, **44**, 335 (1943)].

R. F. BARROW

535.34

850. Spectral transmission of thin films of metals. I. Gold and silver. Y. SOEZIMA. *J. Sci. Res. Inst., Tokyo*, **43**, 252–60 (*Aug.*, 1949).

Direct photoelectric measurements of the transmission factor of thin films deposited on quartz were made for wavelengths between 700 mμ and 220 mμ. The results were not always consistent, but in general the wavelength for min. transmission was that of a spectral line of the element. Other smaller fluctuations were observed, at present not accounted for by theory. N. CORCORAN

535.341–15

851. A low temperature infra-red transmission cell. H. O. MCMAHON, R. M. HAINER AND G. W. KING. *J. Opt. Soc. Amer.*, **39**, 786–90 (*Sept.*, 1949).

A versatile apparatus is described which allows the i.r. absorption spectra of materials to be obtained at temps. down to that of liquid He, 4·2°K. The observed spectrum is the usual transmission measurement obtained in the normal way without disturbing the optics of the spectrometer. Samples can be observed which are solid, liquid, or gas at ordinary temps. Solids and liquids are suitably supported and are surrounded by He gas at the temperature of liquid He in order to provide for heat removal from the sample by both gaseous conduction and convection. The temp. rise of the sample due to absorbed radiation is thus very small. Condensible gases may be deposited on to one side of the vacuum tight i.r. transparent windows bathed on the inner side by cold He gas. Observations have been made for periods of 45 min. using a single charge of approximately 200 cm³ of liquid He. A.

535.343–15

852. Some applications of intensity measurements in the infra-red. R. E. RICHARDS AND W. R. BURTON. *Trans. Faraday Soc.*, **45**, 874–9 (*Sept.*, 1949).

Absolute extinction coeffs. have been measured for the N—H absorption band near 3 400 cm^{-1}, and the C=O vibrations near 1 700 cm^{-1} in a number of compounds. The band areas were obtained by direct integration of an error function which was fitted to the absorption curves. By treating the N—H link as a harmonic oscillator with fixed charges on the nuclei, a value of 0·8D was obtained for the dipole moment of the N—H link. The extinction coeff. of the characteristic carbonyl band at 1 700 cm^{-1} is shown to be related to the polarity of the C=O link. A.

535.343.2–15

853. Infra-red absorption spectra at low temperatures. A. WALSH AND J. B. WILLIS. Letter in *J. Chem. Phys.*, **17**, 838 (*Sept.*, 1949).

An examination has been made of the infrared spectra of several solids at room temp. and at − 180°C. No evidence is obtained for narrowing of the bands with decreasing temp. A. HARVEY

535.343.2–15

854. Infra-red evidence for free rotation in the solid state. L. F. H. BOVEY AND G. B. B. M. SUTHERLAND. Letter in *J. Chem. Phys.*, **17**, 843 (*Sept.*, 1949).

Reports briefly the complete failure, over a period of years, to find any experimental evidence for rotational fine structure in the infrared spectra of the ammonium halides. A. HARVEY

535.343.2–15

855. Evidence from infra-red spectroscopy on the structure of proteins. S. E. DARMON AND G. B. B. M. SUTHERLAND. Letter in *Nature, Lond.*, **164**, 440–1 (*Sept.* 10, 1949).

535.343.32

856. Discontinuous variation with temperature of transparency of aqueous solutions. M. C. OLLIVIER. *C.R. Acad. Sci., Paris*, **228**, 1697–9 (*May* 30, 1949) *In French.*

The transparency of the liquid is measured by a null method; one light beam traverses the liquid and falls on a photocell, while another beam traverses a polarizer and analyser and falls on an identical

photocell acting in opposition to the first. The analyser is adjusted till the net photocurrent is zero; the transmission of the liquid is then deduced from the analyser setting. Sharp discontinuities in the graph of transmission against temp. are found in the case of $Fe(NO_3)_3$ and NH_4NO_3 soln. between 32°C and 61°C. N. CORCORAN

535.343.4

857. Imprisonment of resonance radiation in mercury vapor. D. ALPERT, A. O. MCCOUBREY AND T. HOLSTEIN. Letter in *Phys. Rev.*, **76,** 1257–9 (*Oct.* 15, 1949).

The experiment first performed by Zemansky [*ibid.*, **29,** 513 (1927)] is repeated under conditions of vapour density and enclosure geometry more suitable for comparison with theory. First results show satisfactory agreement between experiment and theory. [See also Abstr. 929 (1948)]. A. HARVEY

535.343.4

858. Measurement of the oscillator strength of the barium resonance line. G. WESSEL. *Z. Phys.*, **126** (*No.* 5) 440–9 (1949) *In German.*

A method is devised for substances not easily vaporized, using an atomic beam as absorbent. The Green Ba line ($\lambda = 5\,536$ Å) is investigated. For resolving very fine absorption lines a Fabry–Pérot interferometer was used, and the interferences photographed. A table records 12 f values measured at different particle density and atom beam oven temps.; $f = 2{\cdot}10 \pm 0{\cdot}25$. J. JACOBS

535.343.4–14

859. The microwave spectra of CD_3Cl and CD_3I. J. W. SIMMONS. Letter in *Phys. Rev.*, **76,** 686 (*Sept.* 1, 1949).

Pure rotational transitions $J = 0 \rightarrow 1$ and $J = 1 \rightarrow 2$ for these molecules respectively have been investigated using a single crystal detecting system. Ratio of intensities of $K = 0 \rightarrow 0$ and $1 \rightarrow 1$ for CD_3I agrees with theoretical predictions. Corresponding molecular dimensions for methyl chloride and iodide respectively are calculated as $d_{CH} = 1{\cdot}10$, $1{\cdot}09$ Å; $< HCH = 111° 24'$, $112° 3'$. These determinations assume that distances and angles in lowest vibrational state are equal for all isotope combinations. J. JACOBS

535.343.4–14

860. Microwave absorption spectrum of methylene bromide. W. J. PIETENPOL AND J. D. ROGERS. Letter in *Phys. Rev.*, **76,** 690–1 (*Sept.* 1, 1949).

Frequencies and relative intensities of 16 lines between 25 200 and 24 900 Mc/s are listed. These were observed using a Stark-effect-modulation spectrograph. J. JACOBS

535.343.4–14

861. Microwave spectrum of CF_3Cl. D. K. COLES AND R. H. HUGHES. Letter in *Phys. Rev.*, **76,** 858 (*Sept.* 15, 1949).

31 lines were observed accompanying the rotational transitions $J = 2 \rightarrow 3$, $3 \rightarrow 4$ round 20 000 and 27 000 Mc/s. Quadrupole coupling constants are $78{\cdot}05 \pm 0{\cdot}2$; $61{\cdot}44 \pm 0{\cdot}4$ Mc/s for CF_3Cl^{35}, CF_3Cl^{37} respectively. From the deduced moment of inertia of the CF_3 group, the internuclear distance are found as 1·323 Å for C–F, 1·765 Å for C–Cl. J. JACOB

535.343.4–1

862. Microwave magnetic resonance absorption i nitric oxide. R. BERINGER AND J. G. CASTLE, J Letter in *Phys. Rev.*, **76,** 868 (*Sept.* 15, 1949).

9 lines of the spectrum for magnetic dipole trans tions in the $^2\pi_{3/2}$ upper doublet component of N with $J = 3/2$ at 9 360 Mc/s and a field of 8 660 gaus are observed and tentatively explained. D. H. WHIFFE

535.343.4–1

863. A theory of pressure absorption. M. MIZU SHIMA. Letter in *Phys. Rev.*, **76,** 1268–9 (*Oct.* 1 1949).

It has been suggested that weak, near infrare absorption recently observed in the case of H, and N may be induced by intermolecular force A formula for absorption of this type is derived. A. HARVE

535.343.4–3

864. Absorption spectrum of benzotrifluoride vapo in the near ultraviolet. H. SPONER AND D. S. LOW *J. Opt. Soc. Amer.*, **39,** 840–6 (*Oct.*, 1949).

The absorption spectrum at 2 750–2 400 Å wa photographed in a medium Hilger quartz spectro graph. The band system can be interpreted in term of an electronic transition $A_1 - B_1$. The 0,0 ban appears strongly at 37 819 cm^{-1}. Several progression of totally symmetric vibrations occur involvin particularly frequencies of 750, 926 and 961 cm^{-1} Other frequencies of 316, 538, 596 and 1 031 cm^{-1} occur singly excited and in combination with the mentioned symmetric vibrations. Bands corre sponding to the excitation of ground state frequencies up to 1 336 cm^{-1} have been observed at highe pressures and found to coincide with Raman fre quencies. The relation of the observed frequencies to modes of vibration is discussed. Spectral position and oscillator strength of the total electronic band is discussed in comparison to benzene, fluorobenzene and toluene. A

535.343.4–31

865. The ultra-violet absorption spectrum of SnO B. EISLER AND R. F. BARROW. Letter in *Proc. Phys Soc., Lond. A,* **62,** 740–1 (*Nov.*, 1949).

New measurements of the Loomis and Watson system [*Phys. Rev.*, **45,** 805 (1934)] are given. Both the upper and the ground vibrational levels appear to converge to a dissociation limit at about 5·7 eV above $v'' = 0$. R. F. BARROW

535.343.4–32

866. The absorption spectrum of nitrous oxide in the Schumann region. J. ROMAND AND J. MAYENCE *C.R. Acad. Sci., Paris,* **228,** 998–1000 (*March* 21 1949) *In French.*

The extinction coefficient of N_2O has been measured in the range 2 150–1 400 Å. No effects of photochemical decomposition have been observed under the conditions used: in particular, the spectrum of NO is absent. R. F. BARROW

535.343.4–32

867. The absorption spectrum of gaseous nitric oxide in the Schumann region. J. Mayence, J. Romand and B. Vodar. *C.R. Acad. Sci., Paris*, **228**, 1799–801 (*June* 8, 1949) *In French.*

Two regions of continuous absorption have been found, one with maximum at 1 820 Å [compare Lambrey, *Ann. Phys.*, **14**, 95 (1930); also Abstr. 1184 (1947)], the other at 1 440 Å. The variation of absorption with pressure and column length has been studied. R. F. BARROW

535.345.6 : 778.3

868. Photographic-photometric calibration of step-filters. H. Kaiser. *Spectrochim. Acta*, **3** (*Nos* 5–6) 518–37 (1949) *In German.*

Visual, photoelectric and photographic methods for the calibration of step filters used in spectrochemical analysis are reviewed in detail. Examples are worked out, and details are given of photographic calibration procedures using an optical bench and movable source, or alternatively using neutral filters. Methods of calculating filter factors at various wavelengths and for various steps with a minimum number of observations are also worked out. A.

535.349

869. On total absorption in spectra with overlapping lines. F. Matossi, R. Mayer and E. Rauscher. *Phys. Rev.*, **76**, 760–4 (*Sept.* 15, 1949).

Total absorption of overlapping lines of equal width but different distances and intensities is calculated. The possibility of deviations from the "root-law" of Ladenburg and Reiche is discussed. A.

535.361.2

870. A photoelectric reflection-transmission densitometer. R. L. Huber and A. B. Rakus. *J. Opt. Soc. Amer.*, **39**, 873–6 (*Oct.*, 1949).

A transmission densitometer has been modified to permit the reading of diffuse reflection density values. Construction details of the reflection viewer added to the densitometer and the accompanying optical and electrical changes are discussed. Performance data are briefly summarized, including observations of density values $> 2{\cdot}0$ for certain glossy photographic papers. A.

535.37

871. Recent investigations on the phosphorescence of organic substances in solid solution. T. Förster. *Naturwissenschaften*, **36** (*No.* 8) 240–5 (1949) *In German.*

A discussion of theoretical views on the nature of the phosphorescing state, especially those of Jablonski on energy levels, and of Lewis on the triplet state attributed to the metastable level. The dependence of decay rates on temp. is considered, also the absorption spectra and magnetic properties associated with the phosphorescing state. S. T. HENDERSON

535.37

872. Zone theory of crystals and the phenomenon of the cold flash. E. I. Adirovich. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13**, 101–14 (*Jan.–Feb.*, 1949) *In Russian.*

The zone theory only refers to semiconductor processes in phosphors and fails to explain the optical processes appearing during recombination in luminescent centres. The first processes are slower than the latter ones and, consequently, they determine the kinetics of the decay. Considerations of decay result in a law of decay $I = A[g/(g + b)]n^2$ [see Adirovich, Abstr. 1361 (1950)]. $G = g/(g + b)$ can be considered as the transparency, $B = b/(g + b)$ as the reflective power of the "thermal barrier." The intensity of the emitted light is diminished by heating and increased by cooling. The author reports on new experiments with ZnS where the "cold flash" could be observed several times, whereupon the crystal had to be heated again to about 80° to produce the same effect. F. LACHMAN

535.37

873. Determination of the absolute yield of luminescence by powdered phosphors. V. V. Antonov-Romanovskiĭ and M. I. Epshteĭn. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 4) 483–6 (1949) *In Russian.*

The authors use a photometric sphere of double-walled quartz, the interspace of which walls (2 mm wide) holds the phosphor in powder form. The sphere (dia. 30 mm) has 2 apertures, through one of which light of approximately the colour of the luminescence light is admitted, whereas the second aperture, the axis of which is perp. to the axis of the first, enables the emitted light to be observed. The absolute energy output is known to be the ratio of the irradiated energy P to the absorbed energy Q, Q being the difference between the energy entering and that leaving the sphere. P can be measured by a thermopile and Q by comparative brightness measurement of the luminescent layer immediately before the monochromator slot, and then in the plane of the exit aperture of the sphere. The two phosphors investigated were ZnS . Cu and Zn_2SiO_4 . Mn. There is no constancy of the output anywhere in the Stokes-range of excitation. The absolute output of ZnS . Cu has a max. of $\sim 0{\cdot}5$ at ~ 360 mμ and a comparatively smooth decline on either side of it. Zn_2SiO_4 . Mn has an output very steeply rising between ~ 310 to 260 mμ to $0{\cdot}6$, which value may remain constant down to 220 mμ. B. F. KRAUS

535.371

874. Investigation of the relation between the yield of photoluminescence and the intensity of the exciting radiation in pure ZnS. P. S. Litvinova. *J. Exp. Theor. Phys., USSR*, **19**, 688–91 (*Aug.*, 1949) *In Russian.*

Excitation of ZnS was produced by using the basic lines of the Hg spectrum, the intensity of the exciting λ being measured by comparison with the intensity of corresponding solutions of fluorescein. The duration of the excitation was 2 min. and the intensity of the luminescence produced was measured by an extinction method. Subjection of the ZnS to preliminary examination showed that luminescence due to impurities in the ZnS was of the order of $0{\cdot}1\%$. The results are given as the yield of photoluminescence relative to the number of quanta falling on the ZnS. The system of curves obtained can be described by the equation $Q(\lambda) = Q_0(\lambda)(1 - e^{-\alpha(\lambda)n})$ where Q is the yield measured, Q_0 the limiting value of the yield, n is the number of quanta and α is a certain

coeff. The general form is the same for all λ's. For large n, the yield has a constant value for long λ's and an almost constant value for shorter λ's. For small n, the yield falls rapidly, tending to a zero value. The longer the λ the steeper the fall, and the sooner the onset of the fall at the lower values of n.

W. HUGHES

535.371

875. Extinguishing of fluorescence and metastable triplet states. A. V. KARYAKIN AND A. N. TERENIN. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13**, 9–17 (*Jan.–Feb.*, 1949) *In Russian.*

An investigation has been carried out of the extinguishing by O of the fluorescence of anthraquinone and 24 of its derivatives, both in vapour and adsorbed state, at a very high vacuum. Table of results contains the following data for anthraquinone, anthrone, anthranol, β-methylanthraquinone, β-oxyanthraquinone, α-oxyanthraquinone, β-aminoanthraquinone, α-aminoanthraquinone, 1,5-dioxyanthraquinone, 1,2,4-trioxyanthraquinone, 1,2,5,8-tetroxyanthraquinone, 1,5-diaminoanthraquinone, and 1,8-diaminoanthraquinone: (1) max. of the fluorescence spectrum of the vapour, in mμ; (2) degree of extinguishing by O in vapour, and adsorbed, state; (3) duration of the state of excitation of molecules (sec). Extinguishing is completely reversible: removal of O reproduces the initial intensity of fluorescence. Extinguishing depends sharply and selectively on the position of the substituting group: groups NH_2, OH, CH_3 in β position produce strong extinguishing by O; if the substituting group is in α position or if there are more substituting groups, no extinguishing can be observed. Extinguishing cannot be due to a chemical process, it is a physical or rather a quasi-chemical process, as in a purely physical process the degradation of electron energy to the motion of heavy nuclei would be extremely improbable. A theory is advanced explaining the extinguishing by O as being due to two essential factors: (1) the O_2 molecule contains in its normal state (triplet electron level $^3\Sigma$) 2 odd electrons which (*a*) impart to that molecule the nature of a radical (bi-radical) with unsaturated valencies, hence capable of a reaction of addition, and (*b*) impart to the O_2 molecule paramagnetic properties; (2) the excited molecule of the fluorescing compound is capable of passing from the valency-saturated state (paired electrons) into the triplet electron state.

F. LACHMAN

535.371

876. Bismuth as activator in fluorescent solids. F. A. KROEGER, J. T. G. OVERBEEK, J. GOORISSEN AND J. VAN DEN BOOMGAARD. *J. Electrochem. Soc.*, **96**, 132–41 (*Sept.*, 1949).

Trivalent Bi forms fluorescence centres in its own compounds as well as in other systems in which it is present as an activator. The fluorescent emission consists of various bands lying between the ultraviolet and the red end of the spectrum. The relative intensity of these bands depends upon the nature of the host lattice and the temp. of observation. Sulphates and phosphates of the alkaline earth group show predominantly red fluorescence. The red fluorescence of $Ca_2P_2O_7$: Bi shows the remarkable feature that its temp. dependence is different for excitation by cathode rays and by X-rays.

535.37

877. The dependence of the output of luminescence of "crystallophosphors" on the wave length of the activating light. M. N. ALENTSEV. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 4) 479–82 (1949) *In Russian.*

The method used (due to Vavilov) consists in comparing the energies scattered on two surfaces irradiated with monochromatic, visible light. On surface is covered with a substance (e.g. MgO) th diffuse scattering coeff. of which is practically independent of wavelength; the second with th substance under test. The investigation was initial carried out in the long-wave part of the spectrum t avoid absorption and excitation of luminescence The total energy (scattered fraction + that converte into luminescent output) was then compared with th emitted energy of the source. By quenching th luminescence with infrared light and continuing th irradiation, the energy absorbed by the phospho could be determined. The phosphors ZnSCu . Cd ZnSCu, ZnCdS show a rapid fall of the outpu between 400 and 500 mμ, starting at much shorte wavelengths than in the case of dye solutions. Thi investigation was extended to include the variatio of the output in the range 200–400 mμ. B. F. KRAU

535.37

878. On the increase of the luminescence o ZnS . Cu, Co phosphor. E. S. KRYLOVA. *Dok Akad. Nauk, SSSR*, **64** (*No.* 4) 495–8 (1949) *In Russian*

This phosphor, which is characterized by a slo increase of its luminescence (without fluorescence was excited by u.v. from a Hg-vapour lamp throug an optical filter with a transmission max. $\sim$ 360 mμ. For a further reduction of the luminescent increase the exciting u.v. radiation was weakened $\sim$ 7 000-fol by a combination of meshes and neutral Pt-filters The curves obtained enable a qualitative theory o the process to be given, the basic features of whic are that during excitation there are not only recom bination but also ionization processes (i.e. of th centres of luminescence). The analysis of the curv and the absence of discontinuities of brightness at th interruption of excitation shows that optical electron do not take part in the process. Deviations from th theoretical curve according to the bimolecular theor of phosphorescence are explained by "amplitud and phase differences" in the development of th process between the surface and deeper layers, an by the participation of fine localization levels. It i surmised that in the very first stages the recombinatio process may have a monomolecular character.

B. F. KRAU

535.37

879. Phosphors in high electric fields. E. KRAUTZ *Z. Naturforsch.*, **4a**, 284–96 (*July*, 1949) *In German.*

A continuation of the early work of Gudden an Pohl and the more recent work of Destriau [Abstr 1806 (1940)]. A new cell is described in detail. Thi has 420 metallic strips separated by distances o 15 μ. Experiments on some 250 phosphors have bee carried out at temps. down to 77°K with fields up t 500 kV/cm. The sudden increase of luminescenc

on the application or decrease on withdrawal of the field is particularly marked with mixed crystals of ZnS . ZnSe activated with Ag and with ZnS . Mn and ZnS . Zn. Decay curves of the effects are shown, obtained with c.r.o. display. In every case the mechanism involved appears to be of the bimolecular type, but with the exponent ($\log I/\log t$) always < 2 and depending on temp., crystal size and field strength and on the time of application of the field after the cessation of illumination. The effects are greater the shorter the normal decay times. Experiments on semiconductors such as ZnO showed luminescence accompanying conduction even when the cell had been assembled and kept in red light. A beginning has been made using the very suitable cell described for investigations on the change of dielectric constant with electric fields. J. EWLES

535.371

880. The rise in brightness of infra-red sensitive phosphors. R. C. HERMAN AND C. F. MEYER. *J. Opt. Soc. Amer.*, **39**, 729–31 (*Sept.*, 1949).

A phenomenological theory of i.r. sensitive phosphors is given which assumes the existence of 2 types of luminescent centres in order to account for the so-called "inertia" effects in the rise of brightness. The equations describing the electron transfer processes have been integrated and show under certain conditions a very rapid initial rise in brightness followed by a relatively slow attainment of the maximum. The effect of varying the intensity of the stimulating i.r. iradiation is discussed. A.

535.371

881. The intrinsic efficiency of the cathodo-luminescence process. R. L. LONGINI. *J. Opt. Soc. Amer.*, **39**, 877–87 (*Oct.*, 1949).

It is shown that the efficiency is the derivative of the light generated as a function of the energy of the electrons striking the phosphor. Ordinary measurements of light output as a function of electron beam energy are corrected for: electrons not striking the phosphor, loss of electron energy in passing through an Al film backing the phosphor, and loss of generated light absorbed in the phosphor layer. The intrinsic efficiency of Zn–CdS proves to be much higher than any previously reported "efficiencies." A.

535.371 : 537.226.2

882. Dielectric changes in phosphors containing more than one activator. G. F. J. GARLICK AND A. F. GIBSON. *Proc. Phys. Soc., Lond. A*, **62**, 731–6 (*Nov.*, 1949).

It is well known that some luminescent materials, notably ZnS, show marked changes in permittivity and dielectric loss when excited. Recent work by the authors has established that the changes are due to the filling of electron traps, which have large effective diameter and high polarizability. The present paper describes measurements of the dielectric changes in phosphors containing two or more luminescence activators. Assuming that the dielectric changes are due to electron trapping, it is possible to derive information regarding the nature of electron traps and in particular their apparent association with the luminescence centres. The results support the contention that the introduction of the activating impurity into phosphors produces trapping states for excited electrons and that each trap forms part of a complex which includes the luminescence centre. A.

535.371 : 538.222

Determination of the paramagnetic susceptibility of a dye in its phosphorescent state. *See Abstr.* 1083

535.371 : 539.164 : 539.166

883. Luminescent output of zinc sulphide excited by α- and γ-rays. T. V. TIMOFEEVA. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 259–62 (1949) *In Russian.*

The experimental method used was that of Abstr. 5365 (1949). The self-luminescence of potassium uranyl sulphate crystals was used as a standard. 16 specimens investigated gave outputs of 0·5–2·6%, with a possible error of 100%. The γ-excited luminescence was investigated by Born, Richl and Zimmer [*Dokl. Akad. Nauk, SSSR*, **59** (*No.* 7) (1948)]. For the γ-ray investigation a 10 mg Ra–MsTh source placed at a distance of 1·5 cm from the ZnS screen was used. The energy absorbed was calculated as that of the two hardest radiations, ThC″ (2·6 MeV) and Ra(B + C) (1·8 MeV), and the efficiency found to be 0·7%. B. F. KRAUS

535.371 : 621.385.832

884. The physics of cathode ray tube screens. G. F. J. GARLICK. *Electronic Engng.*, **21**, 287–91 (*Aug.*, 1949).

Characteristics, with diagrams, of common materials used for screens—particularly spectral, voltage-intensity relations, saturation, efficiency and life.

J. EWLES

535.372

885. Persistence of band fluorescence in mercury vapor. T. HOLSTEIN, D. ALBERT AND A. O. MCCOUBREY. Letter in *Phys. Rev.*, **76**, 1259 (*Oct.* 15, 1949).

The effect of variation in temp. is found to be in direct opposition to that predicted by theory. Further experiments are proposed, in which pressure and temp. will be varied independently. A. HARVEY

535.375.5

886. The Raman spectrum of cadinenic sesquiterpene. V. M. PADMANABHAN. *Curr. Sci.*, **18**, 287–8 (*Aug.*, 1949).

535.375.5

887. Raman and infra-red spectra of β-quartz. B. D. SAKSENA AND H. NARAIN. Letter in *Nature, Lond.*, **164**, 583–4 (*Oct.* 1, 1949).

By comparing the structures of α- and β-quartz, and applying symmetry considerations to find the vibrations allowed in β-quartz, from the observed spectra of α-quartz conclusions can be drawn about the Raman and infra-red spectra to be expected for the β-variety. These are compared with the observed Raman spectrum and the expected frequencies appear. The infrared spectrum has not yet been recorded.

A. C. MENZIES

535.375.5

888. Raman spectra of acetylchloride, acetyl bromide and ethyl bromide at low temperatures. B. M. BISHUI. *Indian J. Phys.*, **22**, 447–52 (*Oct.*, 1948).

All the prominent lines of the liquids appear in the corresponding solids, and it is concluded that there

are no rotational isomers in the liquids. There are two unexpected lines in each of the substances and it is thought that these are due to associated groups of molecules in both states. A. C. MENZIES

535.39

889. A system for preparing semi-transparent mirrors. C. FRÉMONT. *Rev. Sci. Instrum.*, **20**, 620–2 (*Aug.*, 1949).

Apparatus devised to facilitate measuring the reflectance and transmission of semi-metalloid mirrors. The coating filaments surround a tube, up through which light comes for making the tests, and all surfaces, except that being coated, are screened from the filament. Chopped light is used to avoid the effect of light from the filament, and the transmitted and reflected beams are received by photocells followed by tuned amplifiers. A. C. MENZIES

535.39

890. Some properties of thin evaporated films on glass. J. L. ROOD. *J. Opt. Soc. Amer.*, **39**, 854–9 (*Oct.*, 1949).

Properties of thin evaporated films of MgF_2 and of $CaSiO_3$ on glass were studied. Thicknesses of the films were determined from measurements of reflected intensity as a function of wavelength, and indices of refraction computed. Density measurements were carried out for MgF_2 films. All these properties were found to be different from those of the corresponding bulk materials, and furthermore, the properties of the films change with time. Results are given for indices of refraction, densities and ageing effects. A.

535.39

891. Some recent advances in the study of certain optical properties of thin films. P. ROUARD. *Rev. Opt. (Théor. Instrum.)* **28**, 569–77 (*Oct.*, 1949) *In French.*

The reflection factor of thin films of Au and Ag deposited on quartz, for a constant wavelength but different thicknesses, is found to have a min. for a thickness of about 5 mμ. The reflection factor at an Ag/quartz surface is found to exceed that at an Ag/air surface for certain wavelengths. Graphical methods are given for evaluating such reflection factors, and criteria laid down for obtaining any particular factor, in particular 50% and the max. N. CORCORAN

535.39

892. Interference in films [of cryolite, LiF, KCl, etc.], with a totally reflecting boundary. D. KOSSEL. *Z. Phys.*, **126** (*Nos* 3–4) 233–60 (1949) *In German.*

A film is evaporated on to a glass plate; the thickness either uniform or, by use of a rotating sector device, varying continuously with azimuth. On the other surface of the plate is a photographic film; a light source at a pinhole in this latter radiates to the film in all directions. Reflections from glass-film and film-air surfaces give interference fringes on the photographic surface; these are bright and sharp (because of multiple reflections) when there is total reflection at the film-air surface. The angle for total reflection gives the refractive index (μ) of the film; for cryolite, μ varies between 1·050 (evaporation at 10^{-1} mm Hg) and 1·274 (at 10^{-3} mm). Slight modification permits examination of the differently polarized components of the fringes; this shows that most films are doubly refracting ($\Delta\mu = 0{\cdot}004$ to 0·02), behaving as positive uniaxial crystals with optic axis normal to the film; this may be attributed to a fibrous structure in the film. G. F. LOTHIAN

535.3

893. On a paper by Vašíček concerning reflection from multilayer films. W. L. WILCOCK. Letter in *J. Opt. Soc. Amer.*, **39**, 889–90 (*Oct.*, 1949).

After the introduction of a correction due to the phase difference between the first rays reflected from consecutive boundaries Vašíček's recent theory [Abstr. 3149 (1947)] is found to agree with Crook's [Abstr. 1404 (1948)] and the author's results. R. A. WEALL

535.33

894. Transmission and reflection coefficients of aluminium films for interferometry. M. F. CRAWFORD, W. M. GRAY, A. L. SCHAWLOW AND F. M. KELLY. Letter in *J. Opt. Soc. Amer.*, **39**, 888 (*Oct.*, 1949).

The films were obtained by evaporation in vacuo. Deposited at high rates they had a mottled appearance and a high reflectivity R, at low rates they were uniform but of low R. R was determined with an accuracy of $\pm 0{\cdot}3\%$. The difference between the films is being correlated with studies made of their structure with the electron microscope. The reflectivities and transmissivities are represented graphically. R. A. WEALL

535.42 : 621.396.11 : 538.566

Diffraction of an electromagnetic wave through a plane screen. *See Abstr.* 1097

535.43

895. Interference methods of investigating the connection between the structure of a surface wave and the structure of the spots of energy scattering. L. P. MOROZ. *J. Tech. Phys., USSR*, **18**, 303–16 (*March*, 1948) *In Russian.*

The calculation on Huyghens–Frenkel's theory of the microstructure superimposed on the macro-structure of the spots of energy scatter is impossible for a strictly monochromatic point source, partly because in this case the energy maxima do not differ in intensity from other diffraction maxima. However, an optical enlargement changes these conditions and the two kinds of maxima then become distinguishible. A geometrical method has been devised of producing by a Twyman interferometer theoretically pre-determined and/or graphically constructed interference structures, based on arbitrary assumptions. These are then compared with interference spots produced in the normal way in conditions corresponding to those of the forecast and found to be in satisfactory agreement. B. F. KRAUS

535.43

896. The scattering of light by particles with spin 2. M. YA. SHIROBOKOV. *J. Exp. Theor. Phys., USSR*, **19**, 473–80 (*June*, 1949) *In Russian.*

The effective cross-section of optical scattering on a particle of spin 2 is determined by quantum-mechanical correspondence method. It is well known that the effective cross-section for optical scattering, even when determined by the 1st non-vanishing approximation of the excitation theory, increases indefinitely with the frequency of the scattered light, for some kinds of particles. The calculation was based on the Fierz–Pauli wave equations [Fierz,

Helv. Phys. Acta, **12**, 3 (1939) and Pauli, *Proc. Roy. Soc. A*, **173**, 211 (1939)], the solution of which was used for determining the current densities of the spontaneous transition and of the transition under an external field, and for calculating the amplitudes B_{ik} of the non-excited wave functions. The latter have to be determined separately for various values of the spin projection on the direction of movement. As the calculation of current and effective cross-section for an arbitrary value of the energy of the scattered quantum proved to be impossible, only the two limiting cases of small energy of the quantum ($K \ll \kappa$) and large energy ($K \gg \kappa$) were investigated further. B. F. KRAUS

535.43

897. Scattering at matt surfaces. H.-U. HARTEN. *Z. Phys.*, **126** (*Nos* 1–2) 27–34 (1949) *In German.*

The intensity distribution of light scattered from layers of ZnO of various grain sizes has been measured and its dependence on angle of incidence investigated. Departures from the cosine law are interpreted in terms of particle size. Light and electron micrographs of the ZnO layers are shown. M. R. HOPKINS

535.43

898. A study of the mechanism of modified Rayleigh scattering. D. H. RANK AND J. P. MCKELVEY. *J. Opt. Soc. Amer.*, **39**, 762–5 (*Sept.*, 1949).

A study of the mechanism of modified Rayleigh scattering has been attempted by more detailed considerations of the "moving mirror" model. A calculation has been made which yields the order of magnitude of the amplitude of the ultrasonic waves in liquids. The small amplitude obtained is used to explain the persistence of the modified Brillouin components in glycerine when the macroscopic viscosity is so high that the ultrasonic vibrations should no longer be propagated according to the classical hydrodynamic equations. A.

535.434 : 541.182.5

Studies in colloid optics. *See Abstr.* 1310

535.435

899. Light scattering from solutions of charged macromolecules. P. DOTY AND R. F. STEINER. Letter in *J. Chem. Phys.*, **17**, 743–4 (*Aug.*, 1949).

The dimunition in the light scattering per molecule owing to intermolecular interference is considered for solutions of proteins and polymeric electrolytes at very low ionic strength. The basis of the theory is outlined and its implications are tested for solutions of bovine serum albumin. W. R. ANGUS

535.51

900. Remarks on the classical and quantum-mechanical treatment of partial polarization. U. FANO. *J. Opt. Soc. Amer.*, **39**, 859–63 (*Oct.*, 1949).

The methods for the convenient treatment of partial polarization are discussed. In particular, it is shown (1) how to introduce the "Stokes parameters" and the "Poincaré sphere" representation in a direct phenomenological way; (2) how an idealized experimental procedure may illustrate the physical analysis of partial polarization; (3) how the Stokes parameter representation fits naturally into the quantum theory of radiation; (4) how the Stokes method applies to Compton scattering. A.

535.514

901. New normal field polarizers. C. BOUHET AND R. LAFONT. *Rev. Opt. (Théor. Instrum.)* **28**, 490–514 (*Aug.–Sept.*, 1949) *In French.*

Describes a new polarizer which is a modification of the usual Rochon prism; only the ordinary ray passes through. The apparatus can be used as an analyser subject to certain conditions. Also gives an account of American methods used for spectrographic analysis. N. CORCORAN

535.515

902. The spectral dispersion of birefringence, especially of birefringent plastic sheets. C. D. WEST AND A. S. MAKAS. *J. Opt. Soc. Amer.*, **39**, 791–4 (*Sept.*, 1949).

It is shown apparently for the first time how dispersion of birefringence (retardation, phase difference or ellipticity) can be measured through the visible spectrum by the use of a Martens type of polarization photometer and monochromator. Dispersion curves are given for several organic thermoplastic sheets including those with both normal and abnormal dispersion of birefringence, and possible uses for such sheets are suggested. A.

535.515 : 538.612

903. The magnetic double refraction of liquid mixtures. I. Benzene in various solvents. E. J. BURGE AND O. SNELLMAN. *Phil. Mag.*, **40**, 994–1014 (*Oct.*, 1949).

The theory of the refraction and previous experimental studies are reviewed. Measurements are given for benzene in (1) CCl_4, (2) cyclohexane, (3) pentane, (4) hexane, (5) heptane, (6) dodecane. The value of the Cotton–Mouton constant for dodecane is found to be $-2{\cdot}81 \times 10^{-14}$ and this is compared with the values for other paraffins. The results are discussed with reference to the theories of Snellman and of Ramanadham. Complete agreement with the latter is found for the case of benzene in CCl_4. L. S. GODDARD

535.515 : 538.612

904. On the theory of the magnetic double refraction in non-polar liquids. O. SNELLMAN. *Phil. Mag.*, **40**, 983–93 (*Oct.*, 1949).

A simplified theory, involving two corrections to Langevin's theory for gases, is presented. These corrections are for the asymmetry of the polarization cavity, and for the potential barrier round the molecule. The resulting theory agrees well with the data for benzene, but data for more substances are needed. L. S. GODDARD

535.515 : 539.133

905. Dynamical double refraction and the time of relaxation of normal alcohols. V. TSVETKOV AND E. FRISMAN. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 1) 49–52 (1949) *In Russian.*

Values of $M = \Delta n/g\eta$ (where η is the viscosity, and Δn the difference between the two principal indices of refraction when the velocity gradient is g) were determined for 9 normal alcohols between hexyl and ceryl. The experimental values of M were

compared with theoretical formulae of Raman and Krishnan, and of Peterlin and Stuart. The theoretical values are ⩾ those observed: the Raman–Krishnan by a factor of 2 or 3, the Peterlin–Stuart by 10–30. The relative variation in M with the number of C atoms was found to agree fairly well with theory for the lower members of the series, but the experimental variation for higher alcohols was < expected. By combining these measurements of double refraction with others on the depolarization of light scattered by the liquid an estimate was made of the relaxation time of the molecule. This ranges from 4×10^{-12} sec for hexyl alcohol to 3×10^{-10} sec for ceryl alcohol. Both these figures are of a lower order of magnitude than would be expected on theoretical grounds for a molecule of elongated ellipsoidal structure.

A. SCHOFIELD

535.542.1

906. Accurate adjustment of the wedges of a Babinet compensator. H. G. JERRARD. *J. Sci. Instrum. Phys. Ind.*, **20**, 353–7 (*Nov.*, 1949).

The appearance of a fringe system instead of complete darkness when a Babinet compensator is placed in zero azimuth between crossed Nicols indicates that the optic axes in the wedges are not accurately at right angles. A general theoretical analysis of the formation of this fringe system is given. Since, in practice, accurately crossed Nicols are seldom obtained, the analysis is extended to include the case where the angle between the vibration directions of the Nicols differs slightly from $\frac{1}{2}\pi$. Curves are plotted showing the theoretical intensity distribution across the field of view for several selected cases and photographs of actual fringes are shown for comparison. Brief details are given of the use of the fringes to test the wedges before and after they are mounted as a completed compensator. A.

535.55 : 539.319

Investigation of stressed conditions in transparent solid models in a beam of parallel rays of polarized light. *See Abstr.* 1261

535.81 : 548.5

907. Artificial fluorite. D. C. STOCKBARGER. *J. Opt. Soc. Amer.*, **39**, 731–40 (*Sept.*, 1949).

A condensed history of the research on artificial optical fluorite growth which was begun in the middle 1920's and reduced to practice at the Massachusetts Institute of Technology during 1940–45. A.

535.551

908. Theory of birefringence in a flowing medium. N. A. TOLSTOĬ. *Dokl. Akad. Nauk, SSSR*, **59** (*No.* 9) 1563–6 (1948) *In Russian.*

Experiments based on the superposition of the Kerr effect on the Maxwell effect by applying an electric field to the flowing liquid gave exact agreement with Peterlin–Stuart's theory and directly contradict the Raman–Krishnan theory. B. F. KRAUS

535.565

909. The electro-optic effect in uniaxial crystals of the type XH_2PO_4. I. Theoretical. B. H. BILLINGS. *J. Opt. Soc. Amer.*, **39**, 797–801 (*Oct.*, 1949).

When voltage is put across a crystal of the type XH_2PO_4, the index ellipsoid in the crystal is rotated and the length of the axes changes. 2 electro-opti coeffs. are necessary to describe the effect in the mos general plate of the crystal. The necessity for coeffs. is shown from consideration of the crysta symmetry. The behaviour of Z-cut and X-cut plate is treated in detail. For Z-cut plates with the voltag in the Z direction the crystal becomes biaxial with th plane of the optic axes at 45° to the X and Y crystal lographic axis. The retardation along the normal t the plate is directly ∝ the voltage and independent o the thickness. The characteristics of the polarizatio interference pattern for excited X and Z plates ar discussed. A

535.565

910. The electro-optic effect in uniaxial crystals o the type XH_2PO_4. II. Experimental. B. H. BILLINGS *J. Opt. Soc. Amer.*, **39**, 802–8 (*Oct.*, 1949).

It is shown experimentally that when a voltage is applied to the Z direction to a basal section o ammonium dihydrogen phosphate the crystal become biaxial. The normal to the plate is the bisector of the axes and the plane of the axes is inclined at 45° to the crystallographic axes. The location of the axial plane is independent of the magnitude of the voltage. The retardation along the normal is directly ∝ the voltage and is independent of the thickness of the basal section. Photographs are shown of the interference pattern obtained with polarized light when voltage is applied to the crystal. The behaviour of the crystal plate with an alternating voltage is also described. Between polarizers the crystal can operate as a light valve both for short pulses as in a camera shutter or for complex sound waves as in a sound-on-film device. It is shown that with circular polarized light 74% sinusoidal modulation introduces only 3% harmonic distortion. A.

535.566.2/33

911. The anisotropy of the natural rotatory power of tartaric acid. M. LÉVY. *C.R. Acad. Sci., Paris*, **229**, 419–22 (*Aug.* 8, 1949) *In French.*

The rotations from the crystal and from solution are used to determine the magnitude and direction of both the electric moment and the orbital magnetic moment of the electronic orbital responsible for the transition connected with rotation at the D line. The non-bonding $2p$ electrons of the —OH groups are involved. D. H. WHIFFEN

535.64

912. On some aspects of white, gray, and black. R. M. EVANS. *J. Opt. Soc. Amer.*, **39**, 774–9 (*Sept.*, 1949).

In any system which defines colour on the basis of the non-spatial, non-temporal properties of light it is shown that white, grey and black are not colours. The perception of white is shown to be caused by a physical property of the object not associated with its selectivity. This property is the diffusion of light. White is shown to be one extreme of a series starting at clear and passing through various degrees of pale white to a max. Grey is shown to be the perception of the relative visual effectiveness of the light from 2 areas and cannot be seen unless at least 2 areas are present. Black is considered the extreme in lack of relative effectiveness. A.

535.65

913. Visual sensitivities to combined chromaticity and luminance differences. W. R. J. Brown and D. L. MacAdam. *J. Opt. Soc. Amer.*, **39**, 808–34 (*Oct.*, 1949).

Colour discrimination for the general case of combined chromaticity and luminance differences has been investigated by analysis of the errors of visual trichromatic colorimetry. A.

535.833

914. A method of measuring the contrast rendition of telescopic systems. H. S. Coleman, G. W. Arnold, Jr. and W. D. Luedecke. *J. Opt. Soc. Amer.*, **39**, 864–9 (*Oct.*, 1949).

HEAT 536

536.2

915. Solution of steady state temperature problems with the aid of a generalized Fourier convolution. A. W. Jacobson. *Quart. Appl. Math.*, **7**, 293–302 (*Oct.*, 1949).

The use of the finite Fourier transformation is demonstrated. Some basic problems are solved, the solution being expressed in terms of special functions; and by means of a modified Duhamel formula other solutions are expressed as functions of the basic solutions. L. S. GODDARD

536.212 : 537.311.33

916. Thermal conductivity and lattice disorder in semi-conductors. U. Croatto. *Ric. Sci.*, **19**, 696–9 (*July*, 1949) *In Italian.*

If CdO or ZnO are immersed in an O atmosphere at high temp., their electrical conductivity is known to depend on the O pressure, and, assuming that the O fills up *F*-centres and captures free electrons, it may be proved that the relation between conductivity and pressure should be $\log \sigma = \text{const} - \frac{1}{6} \log p$. Measurements were made of the thermal conductivity, and results show that its behaviour is similar. The numerical coeff. was found to vary between 4 and 7, depending on how the material had been prepared. L. PINCHERLE

536.212.2

917. A similarity rule for the thermal conductivity of metals. M. Kohler. *Naturwissenschaften*, **36** (*No.* 6) 186 (1949) *In German.*

The law $\Delta w/w_0 = G(H/w_0 T L_s)$ for the change Δw of thermal resistance in a magnetic field H, similar to that for electrical resistance [Abstr. 2617 (1938)], is proposed and discussed. w_0 is the thermal resistance in zero field, T the absolute temp., and L_s the Sommerfeld value of the Lorenz number. The law is shown to be in agreement with the available experimental values. S. WEINTROUB

536.23 : 533.15

The dependence of the thermal diffusion factor on temperature. *See Abstr.* 775

536.242

918. Heat transfer to liquid metals flowing in asymmetrically heated channels. W. B. Harrison and J. R. Menke. *Trans. Amer. Soc. Mech. Engrs*, **71**, 797–803 (*Oct.*, 1949).

Heat transfer to a fluid in turbulent flow between 2 plane parallel walls is discussed for the case of an asymmetrically heated system in which the entire heat flux is transferred at one of the walls and no heat passes through the other. An annulus for which the ratio of diameters approaches unity may approximate this case in the limit. A few remarks are made regarding experiments which might yield information on the variation of eddy diffusivity near the centre line of a channel, and a method is presented for predicting heat-transfer coeffs. for asymmetrical heat-transfer systems. A.

536.242

919. The influence of an electric field on the convective heat transfer in liquids. R. Kronig and G. Ahsmann. Letter in *Appl. Sci. Res.*, **A2** (*No.* 1) 31–2 (1949).

Results of preliminary measurements on $CHCl_3$ and CCl_4 are briefly reported. A horizontal Pt wire, dia. 20 μ, stretched along the axis of a cylinder, dia. 4 cm, containing the liquid, was electrically heated to a few degrees above its surroundings. Several 100 V applied between the wire and cylinder produced an increase in the heat transfer from wire to cylinder, the effect being greater in $CHCl_3$ than in CCl_4. The order of magnitude is said to fit in with the similarity considerations of Kronig and Schwarz [Abstr. 952 (1948)]. S. WEINTROUB

536.244

920. Theoretical aspects of heat transfer from flames. J. K. Kilham and J. E. Garside. *Commun. Gas Res. Board* (*No.* 47) 26 *pp.* (*April* 16, 1949).

The possible mechanism of energy transfer from flame gases to a solid immersed therein have been considered, and reasons have been advanced for the hypothesis that the bulk of the energy transfer is by forced convection. A method for the determination of the rate of energy transfer in the simple case of gas flow perp. to the axis of a refractory cylinder has been devised, based on the assumption that, at equilibrium, the rate of heat transfer to the solid is equal to the rate of heat loss from the solid by radiation and conduction. A suitable technique for the measurement of surface temp has been developed, and the flame temps. have been measured by means of the spectral line reversal method. Comparison of the measured heat transfer coeffs. with those estimated on the basis of forced convection and radiation shows that for CO-air flames, there is remarkable agreement between the experimental and calculated data, thus supporting the theory that forced convection and radiation account for most of the energy transfer. In the case of H-air flames, however, the results indicate that radiation and forced convection are not the only factors involved in the energy transfer. Calculations show that recombinations of atoms and radicals in the flame gases could contribute about 24% of the total heat transfer. FUEL ABSTRACTS

536.244 : 537.29

921. The effect of electric fields on the heat transfer in gases. H. SENFTLEBEN AND H. GLADISCH. *Z. Phys.*, **126** (*Nos* 3–4) 289–309 (1949) *In German.*

See Abstr. 208 (1949). Graphs of Q against E for various p are given for CH_3Cl, $(CH_3)_2CO$, C_2H_2 and C_4H_{10}. The effect is similar for the horizontal parallel plate capacitor, but E can be so chosen that either a $+$ or $-$ Q occurs. Results for C_2H_5Cl in such a capacitor are shown graphically. The vertical cylindrical capacitor is considered in some detail. The dependence of the effect on p is completely different from that for the horizontal position; for small fields Q first rises more rapidly than p^2, reaches a max. and then decreases as p increases; for large fields Q continues to rise steeply. A simple, accurate method is described for the determination of the permittivity of gases. S. WEINTROUB

536.255

922. Thermal conductivity of powders. Z. KLEMENSIEWICZ. Letter in *Nature, Lond.*, **164**, 589 (*Oct.* 1, 1949).

It is pointed out that the results of Abstr. 1432 (1949) were first discovered by Smoluchowski [*Bull. Int. Acad. Cracovie*, **129** (1910)].

536.421

923. The change of entropy, volume and binding state of the elements on melting. O. KUBASCHEWSKI. *Trans. Faraday Soc.*, **45**, 931–40 (*Oct.*, 1949).

It is shown that the molar heat capacity at the melting point C_p divided by the absolute temp. of fusion T_m and the cubic coeff. of expansion at the melting point α is a measure of the bonding mechanism. The ratio $C_p/(T_m\alpha)$ is nearly constant for the true metals and the meta-metals, but is much greater and varies within wide limits for the semi-metals, and is generally smaller for the non-metals. It is concluded from the co-ordination numbers in the liquid state and the ratio $C_p/(T_m\alpha)$ (liq.) that the semi-metals partially lose their homopolar bonds on melting. This is also evident from the change of entropy and of conductivity on melting. The ratio $\Delta S_m/\Delta V_m$ is again constant for the true metals and the meta-metals, but is much greater or negative for the semi-metals and smaller for the non-metals. Combining this result with Clapeyron's equation a relation is found between the lowering of melting point by pressure and the atomic volume (AV) : $dp/dT = (AV)/\delta_m$, holding true as far as it can be compared with experimental measurements. A.

536.421.4

924. On the depression of [the] freezing point of water due to the internal stress accompanying the transformation. M. SATO. *J. Sci. Res. Inst., Tokyo*, **44**, 6–9 (*Sept.*, 1949).

A relation is derived for the depression or elevation of the transformation point, assuming the heat of transformation to be temp. dependent. The case of water is considered as a numerical example.

S. WEINTROUB

536.423

925. Kinetics of the formation of nuclei and statistical theory of condensation. R. BECKER. *Disc. Faraday Soc.* (*No.* 5) 55–61 (1949).

The problem of obtaining the equilibrium number n of aggregates of n molecules for a gas is treated by thermodynamic and kinetic methods. The kinetic method is less accurate than the thermodynamic approach, but is applicable to systems which are not in equilibrium. The statistical theory of condensation developed by Mayer [*J. Chem. Phys.*, **5**, 67 (1937)] is given and applied to Einstein's treatment of condensation based on Bose statistics. J. A. FRANKS

536.424

926. A room-temperature transition in polytetrafluoroethylene. H. A. RIGBY AND C. W. BUNN. Letter in *Nature, Lond.*, **164**, 583 (*Oct.* 1, 1949).

For polytetrafluoroethylene it is found that the cubical coeffs. of expansion are roughly the same below 15° and above 25°, but that at approx. 20° there is a 1% increase in volume. Evidence is adduced to show that a change in crystal structure occurs near 20°, during which the change seems to be from 3-dimensional order below 20° to a lower order above 20°. W. R. ANGUS

536.424

927. New determination of the initial point of fusion of quartz. C. MARTINEZ. *C.R. Acad. Sci., Paris*, **223**, 612–14 (*Oct.* 21, 1946) *In French.*

Results are recorded of experiments which show that the transformation, quartz → vitreous silica, is a slow one, commencing at about 1 460°C.

L. S. GODDARD

536.45 : 621.365.4

928. Design of equipment for thermal studies. R. J. TEITEL. *Rev. Sci. Instrum.*, **20**, 575–8 (*Aug.*, 1949).

A versatile metallurgical furnace for high temp. investigations of metals and alloys is described. Its uses to conduct thermal analysis and thermal treatments on Be–Fe alloys are described in detail. In order to apply thermal analysis to these alloys, a special thermal crucible was designed and found successful. A.

536.453

929. On the conditions of treatment of substances in the solar oven. F. TROMBE. *C.R. Acad. Sci., Paris*, **228**, 986–7 (*March* 21, 1949) *In French.*

If a small cavity is made in a substance of low thermal conductivity, and that surface exposed to the sun, any material placed in it can be slowly and uniformly heated. By suitable shaping of the cavity, this type of oven can be made highly efficient, provided that the substance to be heated is of low reflecting power. [See Abstr. 558 (1949)].

N. CORCORAN

536.46 : 535.33.03

A new technique for the spectroscopic examination of flames at normal pressures. *See Abstr.* 834.

536.46 : 535.338

Spectroscopic studies of low-pressure flames. *See Abstr.* 841

536.46 : 778.3

Photographic techniques in combustion research. *See Abstr.* 1375

536.461 : 541.127

On the theory of burning velocities in gas-mixtures. *See Abstr.* 1289

536.461 : 541.127

Complex chemical reactions during flow through a nozzle. *See Abstr.* 1290

536.468

930. Inflammability of gases. J. H. BURGOYNE. *Research, Lond.*, **2**, 512–18 (*Nov.*, 1949).

A general review of flame-propagation outside the normal limits of inflammability. Phenomena discussed include cool flames, two-stage ignition (in which a cool flame is followed by a non-thermally-initiated blue flame) and the existence of triple low-pressure limits of inflammability. The review deals mainly with experimental results and their interpretation; experimental techniques are not described in detail. A. SCHOFIELD

536.48

931. On the transfer rate of the Rollin–Simon film. W. J. DE HAAS AND G. J. VAN DEN BERG. *Rev. Mod. Phys.*, **21**, 524–6 (*July*, 1949).

The transfer rate of He II running out of a beaker by film flow was measured by a method in which elaborate precautions were taken to exclude heat radiation, the presence of which might influence the thickness of the film. Contrary to earlier observations [Abstr. 1710 (1939), 3310 (1948)] it was found that the rate was not constant but decreased as the level fell, so that the level fell approximately exponentially with time. The initial transfer rates were up to 17 times larger than those of the earlier meas. [See Abstr. 932 (1950)]. H. LONDON

536.48

932. Surface transport of liquid helium II. R. BOWERS AND K. MENDELSSOHN. Letter in *Nature, Lond.*, **163**, 870–1 (*June* 4, 1949).

Anomalously high transfer rates have recently been observed by Atkins [Abstr. 3310 (1948)] in glass beakers which ended in a large bulb and been ascribed as being due to temperature gradients, and by de Haas and van den Berg [Abstr. 931 (1950)] in an arrangement where temperature gradients were excluded. The author has been unable to confirm these results. On the other hand he did observe that on successively depositing thin layers of solid air on glass surfaces at liquid He temperatures the film transport increased and became dependent on the length of film. Finally, a saturation transport rate was reached at a thickness at which the deposit was still transparent. A layer deposited at 90°K showed only a small increase in transfer. This phenomenon is considered to be the cause of the high transfer rate observed by the other authors. In another experiment in which impure He was condensed into the cryostat, an increased rate of evaporation was observed, due to increased film transport on solid air which had deposited on the pumping line. This illustrates the importance of the phenomenon for cryogenic technique. H. LONDON

536.48

933. The Bose–Einstein condensation for thin films. M. F. M. OSBORNE. *Phys. Rev.*, **76**, 396–9 (*Aug.* 1, 1949).

The distinction is made between a condensation temp. in the thermodynamic sense, where the thermodynamic functions have a discontinuity, and an abrupt accumulation (in the statistical mechanical sense) of particles in the ground state of a system. The criterion for the latter is that an integral will not approximate one term of a sum. The problem of a thin film of gas is solved to illustrate this distinction. For films thicker than a critical thickness a condensation occurs at the same temp. as that for bulk material. The thinner films are effectively 2 dimensional and have an abrupt accumulation temp. lower than the bulk condensation temp. Films of liquid He are briefly considered. A.

536.48

934. Non-equilibrium states in helium II. W. BAND AND L. MEYER. *Phys. Rev.*, **76**, 417–23 (*Aug.* 1, 1949).

It is shown that second sound is thermodynamically possible only in the absence of thermal equilibrium between the superfluid and normal component of He II. The tendency of the assembly to drop back irreversibly to the state of internal equilibrium within a certain time of relaxation provides a consistent account of the observed limitations of superfluidity and heat conductivity in liquid He. As a consequence it is be to be expected that the times of relaxation calculated from heat conductivity measurements should be identical with those which can be derived from Pellam's direct attenuation measurement in second sound. This expectation is confirmed within the accuracy of available data. A.

536.48

935. Non-equilibrium phenomena in a Bose–Einstein gas. I. Transmission of second sound. W. BAND. *Phys. Rev.*, **76**, 558–64 (*Aug.* 15, 1949).

A model Bose–Einstein gas is considered in which numerical perturbations in the population of the lowest state have a relaxation time that is long compared with the relaxation time for perturbations in the symmetry of the velocity distribution in the excited states. Oscillations of the population of the lowest state about its equilibrium value are transmitted as second sound waves. The velocity of transmission is found as a function of temp. below the λ-point and compared with that of second sound in liquid He. In the gas there is a temp.-dependent coupling between pressure waves and thermal waves; the normal modes of propagation are mixed. The high speed mode is pure pressure wave near T_λ, but goes over gradually to pure thermal wave as $T \to 0$°K; the low speed mode is pure thermal wave near T_λ, but goes over gradually to pure pressure wave as $T \to 0$°K. For $T \ll T_\lambda$ the thermal wave has a higher speed of propagation than the pressure (ordinary sound) wave. A.

536.48

936. Very low temperature physics. J. F. ALLEN. *Research, Lond.*, **2**, 467–70 (*Oct.*, 1949).

A brief account of the papers presented to the conference on very low temperatures held at M.I.T. (Cambridge, U.S.A.) from Sept. 6–10, 1949. D. SHOENBERG

536.48

937. The liquid state at the absolute zero and the third law of thermodynamics. A. R. MILLER. Letter in *Nature, Lond.*, **164**, 325–7 (*Aug.* 20, 1949).

Various possibilities for the behaviour of liquid He^3 at very low temperatures are discussed. D. SHOENBERG

536.48

938. Helium three. D. TER HAAR. *Ned. T. Natuurkde*, **15**, 233–42 (*Oct.*, 1949) *In Dutch.*

A review article, dealing mainly with theoretical aspects and including discussion of the properties of the gaseous and liquid phases, the equation of state and the fundamental differences between He^3 and He^4. Numerical data are given and reference made to recent experimental and theoretical work.

E. P. WOHLFARTH

536.48

939. Second sound velocity in helium II. R. D. MAURER AND M. A. HERLIN. *Phys. Rev.*, **76**, 948–50 (*Oct.* 1, 1949).

Pulse methods are applied to extend the measurements to 0·86°K. The rise in velocity below 1·1°K observed by Peshkov is verified and extended to lower temp. The theoretical implications are discussed. A.

536.48

940. The theory of the viscosity of helium II. I. Collisions of elementary excitations in helium II. L. D. LANDAU AND I. M. KHALATNIKOV. *J. Exp. Theor. Phys., USSR*, **19**, 637–50 (*July*, 1949) *In Russian.*

Calculations are made of the cross-sections of phonon-phonon, phonon-roton and roton-roton scattering. The process of phonon-phonon scattering is shown to be a 4-phonon process, and it is found to be essential to take dispersion into account: this is achieved by a comparison with the energy spectrum deduced from the experimental results on the velocity of second sound. The scattering of rotons by phonons is estimated by considering the presence of the phonon as equivalent to a small fluctuation of the density and velocity of the medium, and the roton-roton scattering by taking the interaction of the rotons concerned as a δ-function of their co-ordinates.

R. B. DINGLE

536.48

941. The theory of the viscosity of helium II. II. Calculation of the viscosity coefficient. L. D. LANDAU AND I. M. KHALATNIKOV. *J. Exp. Theor. Phys., USSR*, **19**, 709–26 (*Aug.*, 1949) *In Russian.*

The kinetic equations for rotons and phonons are solved by using the effective differential cross-sections for the scattering of elementary excitations (i.e. phonons and rotons) by each other, as given in I. It is shown that the viscosity of He II is composed of two parts: one caused by the scattering of rotons and independent of temp.; the other, caused by scattering of phonons and sharply increasing with fall in temp. The experimental values for the viscosity of He II appear to be in good agreement with theory.

R. B. DINGLE

536.48 : 530.162

The transition of liquid helium. *See Abstr.* 739

536.48 : 537.312.62

942. The Bose–Einstein condensation for charged particles in a magnetic field. M. F. M. OSBORNE. *Phys. Rev.*, **76**, 400–6 (*Aug.* 1, 1949).

The condensation and accumulation phenomena of charged Bose–Einstein particles in a magnetic field are examined, neglecting electrostatic interactions. For weak fields a single condensation occurs at the same temp. as that for uncharged particles; for strong fields there is a separate lower accumulation temp., indicating the accumulation of particles in the lowest translational state. The total energy, free energy, and polarization are calculated, and applied to the properties of a gas of electron pairs, and a solution of deuterons in a metal, these being systems whose low temp. behaviour might show a Bose–Einstein condensation. It is shown that the Bose–Einstein condensation of free electron pairs cannot provide a theory of superconductivity. A.

536.511

943. Direct experimental comparison of several surface temperature measuring devices. A. M. STOLL AND J. D. HARDY. *Rev. Sci. Instrum.*, **20**, 678–86 (*Sept.*, 1949).

Tests made using a standard surface and under a variety of environmental conditions, on several types of skin thermometers, including radiometric, resistance wire, thermocouple, Hg-in-glass, and thermistor, are described. The standard surface was the outer surface of 4 leather layers on a hollow Cu cylinder containing water, the temp. of which could be maintained constant to $\pm 0{\cdot}03$°C. The surface temp. was extrapolated from the measured thermal gradient in the layers. The relative merits of the several types are assessed, and it is concluded that the radiometric is the most dependable and accurate instrument although requiring corrections when used in simulated sunlight. S. WEINTROUB

536.52 : 535.338.4

Spectroscopic method of measuring temperature, using incompletely resolved bands. *See Abstr.* 848

536.658

944. The integral and differential heats of sorption of water by cellulose. J. C. GUTHRIE. *J. Text. Inst., Manchr.*, **40**, *T*489–504 (*Aug.*, 1949).

The integral heat (W) and the differential heat ($-\Delta H$) of sorption of water on cellulose have been determined for a series of values of the regain c [= 100 (adsorption per g)]: the heat of immersion ($= W$) of the sample of fibre, conditioned to a given regain, was determined calorimetrically and ΔH calculated from the slope of the curve of W against c. The value of $-\Delta H$ is approximately the same for all cellulosic fibres, viz. 297 cal. g^{-1}, supporting the hypothesis that the average constitution of the water-absorbing region of the cellulosic material is the same for all. Entropy and free energy changes are also calculated. W decreases with increasing stretch for Tenasco rayon, indicating a decrease in hygroscopicity with stretching. S. J. GREGG

THERMODYNAMICS 536.7/.8

536.71 : 523.21

The second virial coefficient of helium in the temperature range 0°C to 600°C. *See Abstr.* 777

536.75 : 531.19

945. Statistical basis of thermodynamics. E. A. GUGGENHEIM. *Research, Lond.*, **2**, 450–4 (*Oct.*, 1949).

The main question discussed is how and in what form the laws of thermodynamics follow naturally and directly from a single assumed statistical principle of a general nature. The assumption adopted is that of Darwin and Fowler, i.e. the measurable properties of a closed system having prescribed energy E are correctly obtained by averaging over all accessible quantum states attaching equal weights to all such states. The partition function and free energy are defined, it then being shown that the free energy so defined has the properties of the free energy of thermodynamics. A physical interpretation of entropy is sought and discussed as a measure of "spread" or "accessibility." The final section deals with the reputed increasing property of entropy.

F. E. HOARE

536.753 : 539.13

946. Molecular orientation and entropy of mixing. A. MÜNSTER. *Naturwissenschaften*, **35** (*No.* 11) 343–4 (1948) *In German.*

A statistical mechanical formula derived for the entropy of mixing is in agreement with experiment for chloroform/acetone mixtures. D. H. WHIFFEN

536.76

947. Observations in the field of thermodynamics. A. GIACALONE. *Ric. Sci.*, **19**, 706–14 (*July*, 1949) *In Italian.*

The invariance of the internal energy with temp., and the relation of Kirchoff's reaction equation to the second law of thermodynamics are discussed. It is concluded that Kirchoff's equation should in general be written $(\partial L_{rev}/\partial T)_v = C_{v,f} - C_{v,i} = -\Delta S_v$ in usual notation. [See *Gazz. Chim. Ital.*, 77 (1947)].

S. WEINTROUB

536.77

948. On the thermodynamics of an electron gas. YU. B. RUMER. *J. Exp. Theor. Phys., USSR*, **19**, 757–9 (*Aug.*, 1949) *In Russian.*

If the thermodynamic potential Ω is represented as a function $\Omega(\zeta, T)$ of the chemical potential ζ and temperature T by a contour integral, its functional relation is determined by $\Omega(\zeta, O)$. This is applied to a free electron gas in a uniform magnetic field. In general, if levels ε_i are continuous, $\Omega(\zeta, O)$ is continuous; if also discrete energies, $\Omega(\zeta, O)$ has discontinuous derivatives for critical values $\zeta = \zeta_{Kr}$; near these the Sommerfeld approximation is invalid and anomalies in heat capacity arise. J. JACOBS

536.773

949. The position of the Le Chatelier–Braun principle as general criterion of stability. Z. KLEMENSIEWICZ. *Ark. Fys.*, **1**, *Paper* 12, 293–304 (1949) *In English.*

A scheme comprising: (1) a variational definition of equilibrium based on the invariancy of a determining function for infinitesimal changes of a parameter and (2) an operational definition of stability, brought in connection with the Le Chatelier–Braun principle, founded on the reaction of the system against finite external interference, is considered. The history of the principle of Le Chatelier–Braun is briefly related and a biological principle as necessary complement introduced. Applications of the scheme are illustrated and analysed on a number of examples. The phenomena of natural and artificial stabilization are discussed. Mutual relations of the two definitions and their connections with the principles of mechanics and thermodynamics and the doctrine of energetics are shown briefly. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

950. Mass of a Lorentz electron. S. J. BARNETT. Letter in *Nature, Lond.*, **164**, 714 (*Oct.* 22, 1949).

A simple derivation of the rest mass $m = (2e^2/3ac^2)$ of an electron of radius a, is derived using only a calculation of the momentum of the field and not the energy. Objections to the Heaviside derivation, which uses only energy considerations, do not apply to this method. G. J. KYNCH

537.132 : 530.145

Vacuum polarization in the positron theory. *See Abstr.* 713

537.133 : 539.185

The sign of the magnetic moment of the proton. *See Abstr.* 1246

ELECTROSTATICS . DIELECTRICS 537.2

537.226

951. On Onsager's theory of dielectrics and the spontaneous polarization of crystals. J. PIRENNE. *Helv. Phys. Acta*, **22** (*No.* 4) 479–88 (1949) *In French.*

The assumption of polarization $\propto$ the applied field leads, by an argument due to Onsager, to the absence of spontaneous polarization. This is a circular argument. Assuming only linearity, the same argument leads to a depression of the Curie point, possibly below the point at which dipoles can rotate freely so that the phenomenon may not be observed.

S. MICHAELSON

537.226 : 531.76 : 621.317.3.029.6

952. High-frequency measurement techniques. A. SCHEIBE, W. KROEBEL, A. WEISSFLOCH, R. THEILE, A. STENZEL AND C. SCHMELZER. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt. Germany*] "*Electronics incl. fundamental emission phenomena*," *Pt II*, 211–78 (1948) *In German.*

The standard of frequency at the Physikalisch Technische Reichsanstalt consisted of 9 quartz clocks. Very low operating conditions with anode currents of 20 μA were employed, together with close temp. control of the quartz and the driving circuit. One clock was constant to 1×10^{-8} for 3 years. As test oscillators, triodes with line circuits were used at wavelengths down to 9 cm (Telefunken

triode LD 110); magnetrons were used for shorter waves. Special magnetrons gave outputs of 10 W at 6·8 cm, 0·25 W at 3 cm and 10^{-4}–10^{-5} W at 3·7 mm. Multi-segment tubes gave higher power and when coupled to a cavity resonator a frequency stability of 5×10^{-5}/hr. Problems associated with the construction of frequency spectrometers ranging from long waves to wavelengths < 1 m are discussed. Impedance measurements employed both the voltage distribution and the resonance methods. A large section is devoted to h.f. oscillography. At frequencies above ~ 100 Mc/s it is not possible to obtain a stationary pattern with a synchronized time base, and methods depending on dynamic Lissajous figures and single-stroke deflections have been developed. Lissajous figures depend on the transit time of the electrons between the deflecting fields so that deflections of the same amplitude, but different phase, are produced in the two directions. For the single-stroke methods, special sealed-off tubes have been constructed. An oscillogram of a 1 000 Mc/s sine wave oscillation is shown. A method is described for the direct measurement of field in a coaxial line or cavity by observing the effect of the introduction of a small known discontinuity. Methods of measuring the properties of dielectrics are outlined, attention being drawn to those which enable the effects of permittivity and permeability to be separated.

L. ESSEN (R)

537.226.08

953. New methods for the determination of dielectric constants in the cm-wave-region. E. LEDINEGG AND E. FEHRER. *Acta Phys. Austriaca*, **3** (*No.* 1) 82–110 (1949) *In German.*

Discusses the theoretical basis of cavity resonator methods using a fixed frequency. A general solution is outlined for the integration of Maxwell's equations for a closed, loss-free, circular-cylindrical sector containing horizontal dielectric plates. The results are reduced to a usable form by means of graphical solutions and approximate formulae.

L. ESSEN

537.226.2

954. The Curie constant of $BaTiO_3$ single crystals. H. GRÄNICHER. *Helv. Phys. Acta*, **22** (*No.* 4) 395–7 (1949) *In German.*

The Curie constant, deduced from measurements of the dielectric properties at different temps., is $C = (650 \pm 50)\times10^3$. H. J. H. STARKS

537.226.2

955. Dielectric constant of gases. A. GENNAOUI, R. LACROIX AND C. RYTER. *Arch. Sci.*, **2** (*No.* 2) 371–4 (1949) *In French.*

The permittivity is determined at 9 300 Mc/s from measurements of the change in resonant frequency of a cavity when the cavity is filled with gas. Results are given for the following: chloroform, acetone, ether, alcohol and benzene. E. RUSHTON

537.226.2

956. Theory of barium titanate. I. A. F. DEVONSHIRE. *Phil. Mag.*, **40**, 1040–63 (*Oct.*, 1949).

The theory of dielectric and crystallographic properties is considered. The various crystal transitions are explained by expanding the free energy as a function of polarization and strain. Dielectri constants, crystal strains, internal energy and self polarization are calculated as functions of temp Relations are obtained between the coeffs. in the free energy and the ionic force constants. These are used to estimate some coeffs. not completely determined by experimental data. L. S. GODDARD

537.226.2

957. On titanates with high dielectric constants H. SACHSE. *Z. angew Phys.*, **1**, 473–84 (*Aug.*, 1949) *In German.*

A review of recent published work on high permittivity ceramics containing $BaTiO_3$. E. RUSHTON

537.226.2 : 535.371

Dielectric changes in phosphors containing more than one activator. *See Abstr.* 882

537.226.8 : 548.734

Effect of external stress on X-ray intensity reflected from Rochelle salt crystal. *See Abstr.* 1363

537.228.1 : 538.652 : 621.392.2 : 621.3.012.8

958. Heterogeneous networks. A theoretical study of the interconnection of mechanical with electric and magnetic networks. Piezoelectricity and magneto-striction. A. GONZÁLES DEL VALLE AND M. RODRÍGUEZ VIDAL. *An. Real Soc. Esp. Fis. y Quím.*, **45**, 161–80 (*March–April*, 1949) *In Spanish.*

Equivalent circuits are obtained for piezoelectric crystals and magnetostrictive prisms. Each circuit, considered as applying to mechanical quantities, behaves with respect to velocities and forces in the same way as it would with respect to currents and potentials. Its elements are simple functions of the density, elastic constants and permittivity of the crystal. The electrical properties of the system are then represented by the reciprocal network.

L. PINCHERLE

537.29 : 536.244

The effect of electric fields on the heat transfer in gases. *See Abstr.* 921

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 534.83

Graphical representation of a continuous noise spectrum. *See Abstr.* 817

537.3 : 621.383.4

959. On the variation in background noise of the RCA 931A photo-multiplier with potential of the glass envelope. C. TAYLOR. *J. Phys. Radium*, **10**, 255–6 (*July–Aug.–Sept.*, 1949) *In French.*

It was found that the noise output of photo-multiplier depended on the potential of the glass. The effect was proved to be due to thermionic and photoelectric emission from traces of active material on the inside of the glass. If the tube is used with an earthed metal screen this must not touch the glass, unless the cathode is an earth potential.

A. H. W. BECK (R)

537.311

960. Transport phenomena in the electron gas. M. KOHLER. *Z. Phys.*, **125** (*Nos* 11–12) 679–93 (1949) *In German.*

The statistical fundamental equation of the Bloch–Nordheim model of the electron gas is re-written as a variation theorem and the latter treated approximately by the Ritz method. The transport quantities are then given by the extrema of certain integrals. The general formulae are applied to the B–N model with and without residual resistance. The electrical conductivity is calculated to the third and the thermal conductivity to the second approximation; further, an approximation formula is given for the thermal e.m.f. In all cases expressions which do and which do not include lattice irregularities are given, and the formulae cover the whole temp. range, thus giving a theoretical foundation to the Grüneisen–Bloch resistance formula, the Mathiessen rule and a formula for thermal conductivity by A. H. Wilson which so far, for intermediate temps., were only interpolation formulae. H. LONDON

537.311.3

961. Resistance measurements on Na–NH_4 solutions at low temperatures. M. NÄBAUER. *Z. angew Phys.*, **1**, 423–8 (*June*, 1949) *In German.*

Resistance measurements on Na–NH_4 solutions of various concentrations are reported. As the temp. was lowered a discontinuous fall of resistance by a factor of 1/20 to 1/200 was found for certain concentrations, and this is shown to be due not to superconductivity as supposed by Ogg [Abstr. 1894 (1946)], but to separation of the solution into two phases of different conductivities. D. SHOENBERG

537.311.31

962. Note on the resistivity of gold at low temperatures. C. T. LANE. Letter in *Phys. Rev.*, **76**, 304–5 (*July* 15, 1949).

It is pointed out that the minimum at about 3°K in the resistance-temp. curve of Au [de Haas, de Boer and van den Berg, *Physica*, **1**, 1115 (1934)] cannot be explained on present theory and various possibilities are discussed. D. SHOENBERG

537.311.31

963. Conduction processes in thin deposits of antimony. L. HARRIS AND L. H. SHAFFER. *Phys. Rev.*, **76**, 943–5 (*Oct.* 1, 1949).

Sublimed Sb deposits having a resistivity of 1·35 times massive resistivity have been prepared. Assuming two conduction processes in Sb, the mean free paths for the conducting processes in thin sublimed deposits of Sb were found to be 1 725 Å and 666 Å. $\Delta\rho/\Delta T$ measurements for thin Sb deposits indicate that the trapping of electrons in the surface becomes important for thicknesses $< 1\,000$ Å, and lend support to the concept of surface electronic states in metals. A.

537.311.32 : 537.226

964. The question of the "true" conductivity of solid dielectrics. B. V. GORELIK AND V. T. DMITRIEV. *J. Tech. Phys., USSR*, **18**, 329–32 (*March*, 1948) *In Russian.*

A method of determining the "true" conductivity intrinsically different from the conventional ones is presented, including the determination of the e.m.f. of polarization for the whole range of its existence. The increase of the conductivity in the domain of the e.m.f. of polarization was proved to be consistent with Joffe's theory. B. F. KRAUS

537.311.33 : 536.212

Thermal conductivity of semi-conductors. *See Abstr.* 916

537.311.33 : 537.531

965. Conductivity changes in dielectrics during 2·5-MeV X-radiation. F. C. ARMISTEAD, J. C. PENNOCK AND L. W. MEAD. Letter in *Phys. Rev.*, **76**, 860 (*Sept.* 15, 1949).

The volume conductivity, σ, of the 3 plastic dielectrics examined increases after irradiation. For polyvinyl chloride, σ increases very rapidly, and quickly reaches an equilibrium value of 30× the original value at an irradiation rate of about 400 *R*/min; on stopping irradiation, recovery was half complete in 30 min and 0·9 complete in 16 hr. For vinylidene chloride, σ increases slowly for about 2 hr to a value 3× the original conductivity, and the recovery rate is much slower than for polyvinyl chloride. For polystyrene, after a total irradiation of 5 500 *R*, the conductivity was 2×10^{-17} ohm^{-1} cm^{-1} —a change $\ll$ that reported by Farmer after a total irradiation of only 4 000 *R* [*Nature*, **150**, 521 (1942)]. E. RUSHTON

537.311.33 : 621.315.59 : 621.314.63

966. Physical principles involved in transistor action. J. BARDEEN AND W. H. BRATTAIN. *Bell Syst. Tech. J.*, **28**, 239–99 (*April*, 1949).

See Abstr. 5431 (1949).

537.312.5

967. A photoelectric resistance of bismuth sulphide. B. T. KOLOMIYETS. *J. Tech. Phys., USSR*, **19** (*No.* 1) 126–31 (1949) *In Russian.*

Description of a photoelectric resistance consisting of a layer of Bi_2S_3 precipitated on glass and protected by transparent varnish, the (grid) electrode being directly applied to the surface. The max. sensitivity is in the visual range of the spectrum. Details of the electrical characteristics are given. This resistance is particularly suitable for photoelectric, automatic control systems, being capable of use in direct association with electro-magnetic relays, avoiding the use of valves. INDEX AERONAUTICUS

537.312.5

968. A method for the production of photoelectric layers of very high resistance with PbS as an infra-red sensitive semiconductor. K. FRANK AND K. RAITHEL. *Z. Phys.*, **126**, 377–82 (1949) *In German.*

By rapidly heating the just formed PbS layer to 250°c and cooling immediately after the orange-red PbS has changed its colour to a dark brown, the specific resistance remains $> 10^{12}\,\Omega$ cm. The long-wave threshold is 3·5 μ. W. SUMMER

537.312.5

969. The temperature variation of the long-wave limit of infra-red photoconductivity in lead sulphide and similar substances. T. S. MOSS. *Proc. Phys. Soc., Lond. B*, **62**, 741–8 (*Oct.*, 1949).

Measurements have been carried out on the spectral distribution of the photoconductive effect in layers of PbS, selenide and telluride, at temps. ranging from

room temp. to that of liquid H. It is shown that cooling has a marked effect on the long-wave limit of sensitivity, which increases by as much as 2 μ on cooling with liquid hydrogen. It is shown that depopulation of energy levels due to thermal activation of electrons is not responsible for the shift of spectral sensitivity. The suggestion is made that the shift may be related to the variation of dielectric constant with temp. A.

537.312.5

970. "Non linear" photoconductivity of cuprous oxide. V. E. Lashkarev and G. A. Fedorus. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 2) 195–8 (1949) *In Russian.*

Investigation of oscillographs of photocurrent in Cu_2O at room temp. in total darkness or under biasing illumination, using impulses of light having rectangular waveform, has established that components of the photocurrent differ by magnitude of characteristic time. Max. detected was $3{\cdot}5\times 10^{-2}$ sec, minimum $\leqslant 10^{-4}$ sec. Non-linearity in Cu_2O increases with characteristic time of carriers. It is attributed to the light transferring electrons from levels with long life-time to levels with short life-time. J. LUKASZEWICZ

537.312.5

971. Photosensitivity of metal halides as affected by adsorbed ions. W. A. Weyl and D. P. Enright. Letter in *J. Opt. Soc. Amer.*, **39**, 889 (*Oct.*, 1949).

Examples are given of ions adsorbed on crystal surfaces which produce asymmetric force fields and are thus conducive to photosensitivity.

S. T. HENDERSON

537.312.5

972. Photosensitivity of mechanical mixtures of non-sensitive compounds. W. A. Weyl and A. I. Cramer. Letter in *J. Opt. Soc. Amer.*, **39**, 889 (*Oct.*, 1949).

Non-sensitive substances (possibly including pigments) may become photosensitive when intimately mixed. S. T. HENDERSON

537.312.5 : 621.383.032.21

973. The structure of the energy levels of Sb–Cs cathodes. N. S. Khlebnikov and A. E. Melamid. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 6) 649–51 (1948) *In Russian.*

Experimental investigation of luminescence of Sb–Cs cathodes is described. The energy level diagram is established, and it is shown that the internal photoelectric effect does not take place in the visible part of the spectrum. The width of the conductivity zone of Sb–Cs films is also measured.

A. LANDMAN (R)

537.312.6 : 536.531 : 541.135 : 621.316.8

974. Electrolytic thermistors. F. Gutmann and L. M. Simmons. *Rev. Sci. Instrum.*, **20**, 674–5 (*Sept.*, 1949).

A thermistor for use with alternating current and having a $\frac{1}{2}$-temp. at 300°K of 7·2°C is easily constructed by immersing Pt electrodes in a viscous solution of waterglass. It is 3 times as sensitive as commercial thermistors, withstands a.c. potentials of $>$ 240 V, and its cold resistance and sensitivity are easily controlled. Other electrolytic solutions have been tested, but these, although withstanding high a.c. potentials, are less sensitive. A.

537.312.62

975. Dependence on pressure of the critical temperature of bismuth-alloys. N. E. Alekseevski. Letter in *J. Exp. Theor. Phys., USSR*, **19**, 358–60 (*April*, 1949) *In Russian.*

All the superconductors so far investigated were found to react on tensile stress with a rise, on volume compression with a fall, of the critical temperature. The virtual superconductivity of Bi had been forecast on the knowledge that the thermal capacity of its electrons = 0. It was expected that by subjecting it to bulk pressure $dH_K/dT > 0$ could be obtained, yet 1 000 atm. were applied in vain. Eventually Bi_3Ni specimens were tested, after preliminary tempering, at gradually reduced temperatures and increased pressures. A control specimen was simultaneously tested without pressure or temperature changes. The transition curves of the compressed specimen were found to be shifted towards higher temperatures, and of an extended specimen towards lower temperatures, though the latter effect was very feeble owing to the low mechanical strength of the specimen, which was ruptured by a force of 3 kg. Further tests on Bi_3Ni soldered to pure Sn in a pressure bomb revealed the large resistance jumps characteristic of the transition of the Bi_3Ni into the superconducting state, whereas a smaller jump at a lower temperature corresponded to the Sn-transition. The reversibility of the phenomenon could be proved and the value of $dT_k/dp = 5{\cdot}4\times 10^{-5}$ degr./atm. Similar results were found on Bi_4Rh. B. F. KRAUS

537.312.62

976. A magnetic effect in the transition to superconductivity. K. Steiner. *Z. Naturforsch.*, **4a**, 271–5 (*July*, 1949) *In German.*

Experiments are described in which the temp. of a Sn cylinder in a small magnetic field H parallel to the axis was lowered; a search coil connected to a ballistic galvanometer was wound round the cylinder and a current i could be passed through the cylinder. For $i <$ about 1·2 A the deflection of the galvanometer during the superconducting transition corresponded to the ejection of the flux of H from the cylinder, but for greater currents, this deflection was preceded by one in the opposite direction. Similar effects were found with In and Tl but not with Hg. No explanation is offered. D. SHOENBERG

537.312.62

977. Creation and growth of superconducting nuclei. T. E. Faber. Letter in *Nature, Lond.*, **164**, 277–8 (*Aug.* 13, 1949).

A Sn cylinder can be kept in the normal state even in magnetic fields slightly below critical (supercooling) owing to the absence of a superconducting nucleus. It was found that such a nucleus can be created by lowering the field locally, and it then spreads along the rod at a speed of order 10 cm/sec which increases with the degree of supercooling.

D. SHOENBERG

537.312.62

978. Superconductivity of BiNa. N. E. Alekseevski. *J. Exp. Theor. Phys., USSR*, **19**, 671–2 (*July*, 1949) *In Russian.*

Both electrical and magnetic measurements showed that the alloy BiNa became superconducting at 2·2°K. The critical field-temp. graph had a gradient of 100 gauss/°K as determined magnetically, but about 250 gauss/°K as determined electrically.

D. SHOENBERG

537.312.62

979. Equation of the magnetic threshold curve of a superconductor. G. P. Burns. Letter in *Phys. Rev.*, **76**, 999–1000 (*Oct.* 1, 1949).

The well-known thermodynamic result that a metal which has a T^3 electronic specific heat in the superconducting state must have a parabolic H_c–T curve is derived. [See also Abstr. 444 (1935)].

D. SHOENBERG

ELECTRIC DISCHARGES 537.52

537.523.5

980. Current densities in the cathode spots of transient arcs. J. M. Somerville and W. R. Blevin. Letter in *Phys. Rev.*, **76**, 982 (*Oct.* 1, 1949).

Describes experiments made with transient discharges in air at 1 atmos. pressure, using various metals as electrodes. Discharge currents varied up to 200 A in square pulses of 1–200 μsec duration. Current densities, estimated from microscopic examination of the cathode spots and therefore as lower limits, varied from 9 000 to $1{\cdot}6\times10^6$ A/cm². The results are tabulated. J. D. CRAGGS

537.523.5

981. Arcs with electrolyte cathodes at atmospheric pressure. A. Winter. *Z. Phys.*, **126** (*Nos* 3–4) 281–9 (1949) *In German.*

Arcs were maintained with various electrolytes as cathode. The arc voltages, and voltage gradients, were measured as functions of current. Very often the discharges were in the form of high pressure glows, and some relevant information on dynamic characteristics is given. J. D. CRAGGS

537.523.5

982. The cathode flame of high current carbon arcs. E. Rohloff. *Z. Phys.*, **126** (*Nos* 3–4) 224–32 (1949) *In German.*

Describes various experimental techniques for studying cathode flames, viz. by photographic means and also by mechanical measurements, e.g. of the recoil of electrodes (anodes) due to impact of the vapour jets. The interpretation of the results is given and the translational jet velocities are deduced. Currents are ~ 100 A. J. D. CRAGGS

537.523.5

983. The measurement of propagation velocities of the anode flame in carbon arcs. E. Rohloff. *Z. Phys.*, **126** (*Nos* 1–2) 175–84 (1949) *In German.*

The anode flame velocities in C and Beck arcs were measured by connecting an uncharged condenser across the arc terminals during current flow. The condenser charging, lasting ~ 10^{-4} sec, disturbed the anode crater slightly and caused a transient disturbance of the anode flame which could be photographed as it moved away from the anode. A discussion of the connection between anode flame velocities and the various arc parameters is given, and from a knowledge of the arc temp. at some distance from the anode crater, the temp. of the latter could be deduced. For the C arc under discussion the crater temperature was 7 000–9 000°.

J. D. CRAGGS

537.523.5

984. On the temperature distribution in free-burning carbon arcs. G. Schmitz. *Z. Phys.*, **126** (*Nos* 1–2) 1–11 (1949) *In German.*

A Mach-Zehnder interferometer was used to measure gas temps. in and near the column of an arc in air, carrying currents ~ 3 A. A detailed analysis of the results is given, and a selection of photographs of the fringes. The arc temps. quoted fall from 7 000°K on the axis to about 1 000°K at about 0·7 cm from the axis. J. D. CRAGGS

537.523.5 : 537.527.5

985. Contribution to the study of the electric arc column. J. Labouret. *Rev. Gen. Elect.*, **58**, 357–80 (*Sept.*, 1949) *In French.*

A résumé, including: classification of arcs; results of experimental study of their temp., current density, voltage gradient, and influence of pressure; outline of the kinetic theory of a molecular, ion, and electron gas; and an elementary survey of the quantized levels and radiation using a simplified molecular model. Previous theories, briefly outlined, are considered to fail in explaining the role of gas pressure. A new theory proposed is based on two assumptions: (i) the arc temp. is fixed by the influence of the vibrations of di-atomic molecules; (ii) these molecules undergo an energy cycle—leaving the ground state, passing successively through each energy level as a result of molecular impact, they are finally ionized; at that instant only is radiation emitted when recombination occurs and the radiation is rapidly degraded to heat. By considering the detailed balancing of all excited states, this theory leads to qualitative results in accord with experiment, i.e. potential gradient and current density are each $\propto$ the pressure, but the arc temp. is independent of pressure. Qualitative results are correct only to order of magnitude, and this is considered due to neglect of variation of molecular cross-section on excitations. The H welding arc is briefly discussed.

F. LLEWELLYN JONES

537.523.5 : 621.3.014.31

986. Arcs between moving electrodes. W. B. Kouwenhoven and T. E. Jones. *Elect. Engng, N.Y.*, **68**, 834 (*Oct.*, 1949) [Digest of *Amer. Inst. Elect. Engrs*, Paper **49–129**].

In a new technique for studying characteristics, a high-current d.c. arc is drawn between a fixed rod and a moving steel tape. With the tape positive, anode spots tend to anchor there, and so to move in sudden jerks to give a series of spots on the tape due to molten metal: with the tape negative, spots are less stable and so tend to form a continuous trail.

Thus energy input at anode is more localized than at cathode spots. F. LLEWELLYN JONES

537.525

987. The admittance of high frequency gas discharges. E. EVERHART AND S. C. BROWN. *Phys. Rev.*, **76**, 839–42 (*Sept.* 15, 1949).

The admittance of a h.f. gaseous discharge between parallel plates has been measured as a function of pressure and discharge current. The susceptance is observed not to be $\propto$ the conductance. In fact the discharge susceptance changes sign from negative at low pressures and low electron densities to positive at high electron densities and high pressures. The discharge admittance is expressed as a volume integral over the complex conductivity. The non-linear relationship between discharge susceptance and conductance is shown to be a consequence of the non-uniform electron density along the direction of the field. A.

537.525 : 621.385.1

988. Breakdown and maintenance of microwave discharges in argon. S. KRASIK, D. ALPERT AND A. O. MCCOUBREY. *Phys. Rev.*, **76**, 722–30 (*Sept.* 15, 1949).

The breakdown fields for A were measured in a resonant cavity at 3 000 Mc/s over a pressure range from 3 to 100 mm Hg. The discharge gap approximates the case of a uniform field between parallel plates. The results are compared with predicted values derived from Holstein's theory; the agreement is within $\sim 5\%$. Measurements taken with the discharge in the cavity permit determination of the voltage/current characteristics of the A microwave discharge. These are given for a set of pressure values. These characteristics are compared with results on positive column gradients in d.c. discharges. A.

537.525.5 : 621.791.73

989. Short time phenomena in the iron welding arc. Metal bridging and short circuiting of the arc. L. H. ORTON AND J. C. NEEDHAM. *Rep. Brit. Elect. Allied Industr. Res. Ass.* (*Ref. Z/T*73) 16 *pp.* (1948).

S.c. phenomena revealed by c.r.o. analysis of the d.c. arc have been arbitrarily classified into 4 groups according to the order of their duration, i.e. 10^{-2} (major), 10^{-3}, 10^{-4} and 10^{-5} sec. Under the conditions investigated, i.e. an arc column gradient of ~ 22 V/cm, major s.c.'s are associated with the actual transfer of liquid material. Minor s.c.'s appear to precede the former, but have also been observed to occur independently. Minor and ultra-short phenomena only account for $\sim 4\%$ of the total s.c. period and only for an even smaller fraction of the material transferred. J. H. O. SMERD (R)

537.525.8

990. Cathode sputtering in the abnormal glow discharge. R. HANAU. Letter in *Phys. Rev.*, **76**, 153–4 (*July* 1, 1949).

Further information [see Abstr. 6222 (1949)] on the pressure/intensity relation for various spectral lines emitted from a He low voltage arc, in a Geissler tube, is given. A discussion of sputtering phenomena with Al or Al alloy cathodes in the same form of discharge follows and, finally, the relevance of certain observed discontinuities in the current/pressure characteristics is outlined. All this information is of importance if long-life sealed-off tubes, with strong emission in desired spectral regions, are required. J. D. CRAGGS

537.525.8

991. High frequency discharges localized along tracks of ionizing particles. A. R. BEVAN. Letter in *Nature, Lond.*, **164**, 454–5 (*Sept.* 10, 1949).

The apparatus consisted of a sealed tube, containing Ne/I, placed in a gauze waveguide which was excited by 1·4 μsec pulses from a 3 000 Mc/s magnetron. The passage of α- and β-particles through the tube, the entry to which was a mica end window, was accompanied by the emission of flashes of light. Photographs of the latter are given. J. D. CRAGGS

537.527

992. Theory of the high pressure helium discharge. V. J. FRANCIS. *Phil. Mag.*, **40**, 1063–72 (*Oct.*, 1949).

The characteristics of the discharge are calculated by the method used in previous papers [Abstr. 1536, 1872 (1947); 3240 (1949)]. These are compared with those of high pressure Hg vapour. A loading of the order of 10^4 W/cm of arc is required to produce conditions usually associated with the normal operation of the high pressure Hg vapour discharge at 10 to 100 W/cm of arc. L. S. GODDARD

537.529

993. Electrophotography of internal discharges in dielectrics. J. H. MASON. Letter in *Nature, Lond.*, **164**, 451 (*Sept.* 10, 1949).

Describes a method of detecting and demonstrating internal discharges in composite blocks of dielectrics. A photographic film is placed between two insulating discs, on the outer surfaces of which metallic electrodes, for the purpose of establishing an electric field in the block, were deposited. Discharges in a small air pocket adjacent to the emulsion give developable images on the film. J. D. CRAGGS

X-RAYS 537.531

537.531 : 535.312

994. X-ray optics: Imperfections of optical flats and their effect on the reflection of X-rays. W. EHRENBERG. *J. Opt. Soc. Amer.*, **39**, 746–51 (*Sept.*, 1949).

It has been observed that some stray light (X-rays) is thrown into the neighbourhood of the focus obtained if X-rays are focused by a bent optical flat. Most of this extra light is due to imperfections of the optical flats, while halation, Fresnel diffraction at the slits and air scattering make only minor contributions. An analysis of the distribution of this extra light, a study of the effect of controlled irregularities and pin hole images of surfaces taken with X-rays lead to definite conclusions about the structure of such surfaces. A.

537.531 : 535.312

995. X-ray optics: The production of converging beams by total reflection. W. EHRENBERG. *J. Opt. Soc. Amer.*, **39**, 741–6 (*Sept.*, 1949).

The total reflection of X-rays is applied to focusing the rays issuing from a fine slit. A method of computing the geometrical optics of surfaces of bent beams is given; it is shown that under certain conditions lateral aberrations for practical apertures are of the order of one micron or less. These results are confirmed by experiment. A.

537.531 : 535.33.072

996. Dead time and non-linearity characteristics of the Geiger-counter X-ray spectrometer. L. ALEXANDER, E. KUMMER AND H. P. KLUG. *J. Appl. Phys.*, **20**, 735–40 (*Aug.*, 1949).

The satisfactory use of Geiger-counter methods for the measurement of diffracted X-ray intensities demands that the observed counting rates be corrected for the non-linear response of the counter. Both the multiple foil method of calibrating the non-linearity of response and the two-source method of Beers for measuring counter dead time have been found to be unsatisfactory approaches to this problem. The authors' experience indicates that electronically controlled oscillographic techniques for the direct measurement of dead time are much more satisfactory. With a knowledge of the dead time, τ, the true counting rate, N, can be calculated from the observed counting rate, N_0, by employing the formula $N = N_0/(1 - N_0\tau)$. For a pulsating X-ray source the effective counting rate is faster than the observed by a factor which is characteristic of the type of rectification employed, the target material, and the voltage applied to the X-ray tube. A sufficiently accurate value of this factor can be arrived at by oscillographic observation of the pulse pattern and in some cases by mathematical analysis. A.

537.531 : 535.343

997. Notes on the *K* and *L* white absorption lines. Y. CAUCHOIS. *C.R. Acad. Sci., Paris*, **228**, 1720–2 (*May* 30, 1949) *In French.*

When an X-ray discontinuity is immediately followed, towards high energies, by a very pronounced absorption max., the photographic spectrum shows a white line. It indicates that there is a large probability of transition from the energy level in question to a band containing a large number of unoccupied states. This absorption and its variation in different compounds have been studied for a large number of elements. R. B. SHEPHERD

537.531 : 535.43

998. An experimental study of back-scatter with X-ray beams of small area. D. V. MABBS. *Brit. J. Radiol.*, **22**, 600–4 (*Oct.*, 1949).

Measurements have been made with a micro ionization chamber of the back-scatter produced by X-ray beams of < 10 cm dia. in the quality range H.V.L. $= 0{\cdot}06$ mm Cu to $1{\cdot}4$ mm Cu. A table of values for back-scatter in a water phantom from these small beams is given. Values for the intermediate beam diameter of 10 cm are compared with those previously published; and causes of discrepancy are discussed under the headings: (1) Phantom material and (2) Radiation cut off by the stem of the measuring ionization chamber. A.

537.531 : 539.166

999. Mean square angles of bremsstrahlung and pair production. M. STEARNS. *Phys. Rev.*, **76**, 836–9 (*Sept.* 15, 1949).

The mean square angles have been derived and formulae for them are given in terms of the energies of the particles involved, the target material, and the max. angle up to which the integration is taken. Calculations from these formulae have been made for incident energies between 50 and 300 MeV and for a maximum angle of 20°, and these have been graphed. It is shown that the root-mean-square angle of bremsstrahlung is $\propto \mu/E_0 \ln E_0/\mu$, and similarly for pair production. The dependence of the mean square on the max. angle of integration is briefly discussed. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.7

1000. On the penetration of 17 Mev electrons. M. AGENO AND M. CHIOZZOTTO. *R.C. Ist. Super. Sanità*, **11** (*Pt* 6) 1472–88 (1948) *In Italian.*

Using an apparatus in triple coincidences of high resolving power, curves of absorption of electrons up to 17 MeV are drawn under good geometrical conditions. For this purpose, the secondary electrons produced in Al by the γ-quanta of $17{\cdot}6$ MeV of the reaction $Li^7(p, \gamma)$ are used, and as adsorption materials Al, Fe, Cd, Pb and paraffin. The absorption curves show long "tails" of intensity $> 2\%$ of the incident electronic radiation, partly due to secondaries of this radiation. The penetration data (reduction to $\frac{1}{2}$, 5% and 1% respectively) in terms of the atomic number show a regular decrease with increase of Z. A.

537.533.72 : 539.163.2

1001. Optimum conditions for a 180° beta-ray spectrometer. C. GEOFFRION. *Rev. Sci. Instrum.*, **20**, 638–40 (*Sept.*, 1949).

The relations existing between source dimensions, beam divergence, luminosity and resolving power of a 180° homogeneous field spectrometer are established. From these the conditions for max. luminosity for a given resolving power are derived. By increasing the source height and slightly decreasing the width, the luminosity may be increased without affecting the resolving power. A.

537.533.72 : 621.385.833

1002. An astigmatic electron lens which can be simply adjusted for refracting power and azimuth. O. RANG. *Phys. Bl.*, **5** (*No.* 2) 78–80 (1949) *In German.*

Following a suggestion of Scherzer a correcting field which can be rotated electrically is used. Six electrodes are arranged symmetrically around the optic axis. Opposite pairs are connected together, one pair being connected to the anode and the others to variable potential sources. This electrical eccentricity corrects the mechanical eccentricity of the main lens. A. H. W. BECK

537.533.72 : 621.385.833

1003. Conference on electron microscopy, Delft. V. E. COSSLETT. *Nature, Lond.*, **164**, 481–3 (*Sept.* 17, 1949).

Report of the international conference held under the auspices of the Netherlands Physical Society. 45 papers on theoretical and practical electron microscopy were presented. The question of eliminating astigmatism was particularly stressed as was the technique for preparation of specimens. Papers of metallurgical and biological interest were also presented. A. H. W. BECK

537.533.74

1004. Experiments with electrons moving in a circular path. R. KOLLATH. *Phys. Bl.*, **5** (*No.* 2) 66–8 (1949) *In German.*

Reference is made to Mott's theory of the polarization of electrons by double scattering. It is suggested that the polarization could be investigated by using electrons moving in semicircular paths under the influence of a transverse magnetic field, allowing them to be scattered twice by thin Au foil and observing the asymmetry in the scattered intensity distribution. It is claimed that, experimentally, this method would have certain advantages over that in which the electrons move in straight paths. M. R. HOPKINS

537.533.74 : 530.145

1005. On the infra-red catastrophe in the problem of electron scattering. T. SEBE. *Progr. Theor. Phys.*, **3**, 304–11 (*July–Sept.*, 1948).

The infrared catastrophe would be adequately dealt with in the radiation damping theory if virtual processes were properly allowed for in the perturbation theory [Abstr. 358 (1947)]. A method is given for including these virtual processes, which leads to a modified integral equation. The catastrophe is then avoided, the simple divergent term being completely compensated by the radiative correction. G. J. KYNCH

537.533.74 : 538.3 : 530.145

The problem of vacuum polarization. *See Abstr.* 715

537.533.8 : 621.385.15 : 621.383.032.21

1006. Secondary emission of Sb–Cs cathodes. B. I. DYATLOVITSKAYA. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 6) 641–4 (1948) *In Russian.*

New experimental data are submitted, based on the "wedge" technique—a Sb–Cs wedge on a Pt plate serving as the secondary electron emitter and facing a Sb–Cs photocathode acting as a primary electron source. The depth character of the secondary emission is clearly shown, and the quantitative emission characteristics are obtained. A. LANDMAN (R)

537.533.92 : 548.7

Distribution of ionization density in a KCl crystal irradiated with high-velocity electrons. *See Abstr.* 1362

537.534

1007. The energy distribution of slow positive ion beams. G. D. YARNOLD AND H. C. BOLTON. *Phil. Mag.*, **40**, 956–68 (*Sept.*, 1949).

A plane cathode separates an ionized region (I) in which the gas pressure is p, and in which there is an electric field, from a region (II) which is evacuated. A small hole is pierced in the cathode, and a beam of ions, of small solid angle, is obtained in region II. The energy distribution in the beam is determined. It depends on the field in region I, and on the variation of the total collision cross-section of the ions as a function of the velocity. The 4 cases treated are uniform field, or Aston field, and constant or variable collision cross-section. The distribution curves follow closely those obtained by experiment.

L. S. GODDARD

537.534

1008. Mass spectrometry. H. G. THODE AND R. B. SHIELDS. *Rep. Phys. Soc. Progr. Phys.*, **12**, 1–21 (1948–49).

Developments in the use of mass spectrometers for relative abundance measurements are reviewed, with references. Direction focusing of constant-velocity ions is normally used; new types of instruments such as those depending on time-of-flight are mentioned. Improvements in electronic technique have aided operation. The usual types of ion sources for solid and gaseous samples are described. Slightly different thermodynamic properties of isotopes of light elements, causing variations in natural abundances, give much scope for accurate mass spectrometric measurements; accurate work on the abundance of C^{13}, O^{18} and the recently discovered variations in B and S isotopic abundances are discussed. High precision (better than 0·1%) can be obtained in relative measurements between 2 samples by instrumental developments such as double collection and feedback methods, or by rapid automatic scanning. Causes of discrimination, producing inaccuracy in absolute measurements, are discussed in some detail. Mass analysis of gaseous fission products with 1 mm^3 sample has been possible, and the masses of the β-decay chains have been assigned. Half-life determinations, and work with non-gaseous fission products, have also given good results.

T. G. PICKAVANCE

537.534 : 615.849

1009. A 30-million volt synchrotron for medical use. *Nature, Lond.*, **164**, 726–8 (*Oct.* 29, 1949).

Description of the 30 MeV synchrotron at the Royal Cancer Hospital, London.

537.534 : 621.384.6

1010. The dynamics of a synchrotron with straight sections. N. M. BLACHMAN AND E. D. COURANT. *Rev. Sci. Instrum.*, **20**, 596–601 (*Aug.*, 1949).

The equations describing the "betatron" and "synchrotron" oscillations of a particle under acceleration in a synchrotron having straight sections are obtained. In particular, the relative increase in the ratio of either betatron-oscillation frequency to the frequency of revolution is found to be $\simeq \frac{1}{2}$ the ratio of the total length of straight sections to the orbit circumference. The effect of magnetic fringing fields is considered. With regard to the synchrotron phase oscillation, it is found that the criterion of non-relativistic adiabatic damping is no longer that n exceeds $\frac{2}{3}$ but that it exceeds $\frac{2}{3}$ by at least $\frac{1}{3}$ of the ratio of the total length of the straight sections to the orbit circumference. A.

537.534.72

1011. Focal properties and resolving power of magnetic fields defined by parallel planes. R. VAUTHIER. *C.R. Acad. Sci., Paris*, **229**, 181–3 (*July* 18, 1949) *In French.*

The theory is developed and it is shown that such a device should have practical applications in mass spectrographs, especially those used for abundance measurements. A. H. W. BECK

537.534.72

1012. On the two-directional mass spectrometer. A. SUGIMITO. *J. Sci. Res. Inst., Tokyo*, **43**, 233–40 (*Aug.*, 1949).

The motion of ions through a sector-field mass spectrometer is analysed after the manner of Shull and Dennison [Abstr. 2167 (1947)] for arbitrary sector angle between 0 and $2\frac{1}{2}\pi$; conditions for 2-directional focusing (perp. and parallel to the field) are derived, and image widths are calculated, in terms of the magnetic field distribution. Second-order defocusing is calculated, and curves illustrating the results are given. T. G. PICKAVANCE

537.534.74

1013. Inelastic scattering of deuterons. G. W. GREENLEES, A. E. KEMPTON AND E. H. RHODERICK. Letter in *Nature, Lond.*, **164**, 663–4 (*Oct.* 15, 1949).

When deuterons are scattered by Al and Mg foils, the energy spectrum of particles scattered through a given angle contains some groups of considerable intensity. The excitation energy of the target nucleus, calculated on the assumption that a group consists of deuterons, agrees well for some groups with that for protons. The doubtful alternative that the particles are protons arising from a (d, p) reaction is eliminated by a study of their range with scattering angle and the incident d energy between 4·96 and 6·65 MeV. The evidence of photographic plate tracks is in agreement with this conclusion, though it is not conclusive. The groups correspond to excitations of 0·88 and 2·15 MeV in Al and 1·36 MeV in Mg, with cross-sections similar to those of the corresponding proton cross-sections. G. J. KYNCH

537.534.74

1014. Proton-proton scattering at 5·11 MeV. R. O. BONDELID, P. G. BOHLMAN AND K. B. MATHER. Letter in *Phys. Rev.*, **76**, 865 (*Sept.* 15, 1949).

Coincidences were recorded between protons emerging in directions at 90° to each other from thin foils of polyethylene terephthalate bombarded by H_2^+ ions from a cyclotron. The number of H atoms/cm² in each foil was found by weighing and analysis, and the incident beam current was measured to $\pm 0{\cdot}75\%$. Values are given of the absolute differential cross-section for scattering angles between 60° and 120° (centre of mass system). Strong deviations from Mott scattering were found. A. P. FRENCH

537.534.8

1015. Problem of the secondary electron emission under the action of negative ions. V. M. DUKELSKI AND E. YA. ZANDBERG (SANDBERG). *J. Exp. Theor. Phys., USSR*, **19**, 731–8 (*Aug.*, 1949) *In Russian.*

Comparative measurements of the coeff. of secondary electron emission of a Pt-target under bombardment with I^- and I^+ ions in the energy interval from 300 to 1 040 eV and with Na^- and Na^+ ions from 290 to 2 200 eV. In both cases the coeff. was considerably higher for negative than for positive ions of the same energy value. An explanation of this fact is attempted by assuming that in the case of negative ions part of the observed secondary electrons has come from the negative ions themselves disintegrating on the target surface. B. F. KRAUS

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 621.385.2

1016. Diode space charge for any initial velocity and current. L. PAGE AND N. I. ADAMS, JR. *Phys. Rev.*, **76**, 381–8 (*Aug.* 1, 1949).

The space charge equation is solved for any initial velocity which is the same for all electrons and for any realizable current, for (*a*) the plane diode, (*b*) the cylindrical diode. For the plane diode it is shown that all cases can be obtained from a single pair of master curves. For the cylindrical diode a series valid for large distances from the axis is obtained first, the form of which shows that the complete group of solutions form a bounded set. Next 3 solutions valid for small distances from the axis are obtained by means of which the first set of solutions can be extended. In addition to master curves representing these solutions, curves are plotted for special values of the initial velocity and current. [See also Abstr. 509 (1946)]. A.

537.542 : 621.385.15

1017. A microwave secondary electron multiplier. M. H. GREENBLATT. *Rev. Sci. Instrum.*, **20**, 646–50 (*Sept.*, 1949).

The construction and operation of a dynamic electron multiplier, of the type sometimes called a multipactor, is described. It consists of 2 parallel secondary emissive plates having an alternating voltage across them. The magnitude of the voltage is adjusted so that the transit time across the gap for electrons starting with zero velocity from one of the plates when the field is passing through zero $= \frac{1}{2}$ the period of the a.c. voltage. Thus electrons and their secondary descendants can be made to bounce back and forth between the plates and multiplication takes place. The necessary phase relationships between the electrons and the field are discussed. The multipactor described uses 10 cm microwave power to obtain the a.c. voltage. It has been used as a γ-ray detector in which case the cavity is "broken down" by the multiplication of a Compton electron ejected from the cavity wall by a γ-ray. This breakdown gives rise to a microwave pulse several mV high at a crystal rectifier. The efficiency of this process is about $1{\cdot}5 \times 10^{-5}$ count/γ-ray. The rise time of the pulse is calculated to be about 5×10^{-10} sec and measured as $< 10^{-7}$ sec. The dead-time is presumed to be $\sim 5\ \mu$sec. A.

537.542

1018. Speed of operation of Geiger–Müller counters. H. DEN HARTOG. *Nucleonics*, **5**, 33–47 (*Sept.*, 1949).

A summary of the theory and recent experimental

data on the time factors involved in the operation of G.M. counters. The operation of a counter by the action of an ionizing radiation can be divided into 4 stages, viz. the delay before the discharge becomes observable; the development of the discharge; the quenching of the discharge and the dead-time. The Geiger discharge starts when secondary electrons, produced by the passage of an ionizing radiation, migrate close enough to the central wire to produce an avalanche and the initial delay is consequently determined by the transit time of these secondary electrons. Experimental results on electron mobilities, drift velocities and transit times in various counter fillings are quoted. The rate of rise of the Geiger pulse in self-quenching counters is determined by the speed at which the discharge spreads along the central wire. The theories of Wilkinson and of Alder *et al.* are described and some experimental data on the velocity of propagation of the discharge is given. The discharge of a G.M. counter is cut off by the +ve space charge which accumulates around the central wire, but can be continued as a result of electron emission from the cathode, either by absorption of photons or by the so-called γ-effect, if there is no organic quenching agent present. The theory of quenching by the use of high series resistance is outlined. Finally the dead-time of the self-quenching counter (determined by the time taken for the transit of the positive ion sheath to the cathode) is discussed and some experimental observations are described. The influence of the dead-time on losses at high counting rates is considered and circuits for reducing the dead-time (by voltage reversal) and for recording automatically the correction to be applied to observed counting rates, are shown. L. R. SHEPHERD

537.542

1019. Use of anthracene crystals in scintillation counters. O. HUBER, F. HUMBEL, H. SCHNEIDER AND R. STEFFEN. *Helv. Phys. Acta*, **22** (*No.* 4) 418–20 (1949) *In German.*

A detailed description of a method for producing large anthracene crystals (3 cm dia. × 2 cm long) is given, with a scale drawing of the melting oven. The crystals were tested with the γ-rays from Co^{60}, and an efficiency of 12% was obtained in a particular experiment described. J. D. CRAGGS

537.542

1020. Coincidence arrangement for scintillation counters. K. P. MEYER, E. BALDINGER, B. HAHN AND P. HUBER. *Helv. Phys. Acta*, **22** (*No.* 4) 420–4 (1949) *In German.*

The systems described use RCA tube 931A with Ge diodes. A threefold coincidence circuit for investigating coincidences between scintillations in two crystals (two independent viewing systems on one crystal) is shown to remove the necessity of cooling the crystals. J. G. WILSON

537.542

1021. An impulse recorder using a multivibrator. S. I. KAPLANSKIĬ AND A. A. RYABOV. *J. Tech. Phys., USSR*, **19**, 634–6 (*May*, 1949) *In Russian.*

Circuit and performance details are given.

E. P. GEORGE

537.542

1022. Design of grid ionization chambers. O. BUNEMANN, T. E. CRANSHAW AND J. A. HARVEY. *Canad. J. Res. A*, **27**, 191–206 (*Sept.*, 1949).

Conformal representation theory is applied to a grid ionization chamber having plane parallel electrodes to give formulae useful in design. Expressions are obtained for the inefficiency of grid shielding of the electron collector, the spread of pulse size caused by the induced effect of positive ions, and the proportion of electrons collected by the grid. The theory was verified by experiment. The width of the Po α-particle line at $\frac{1}{2}$-max. was reduced to 50 keV or about 1% of the energy by the use of a suitable grid and operating voltages. The corresponding standard deviation from all causes was 22 keV, made up of 2 keV resulting from induced effect of positive ions, about 17 keV from noise in the amplifier, and 14 keV from straggling of ionization, thickness of source, and other effects. The spread caused by positive ions can therefore be almost completely eliminated by a grid. A.

537.542

1023. A counter-controlled cloud-chamber with an explosion mechanism. M. POLLERMANN. *Z. Phys.*, **126** (*Nos* 3–4) 261–70 (1949) *In German.*

A cloud chamber mechanism is described in which the chamber piston is driven by the ignition of a H-air mixture in an auxiliary explosion cylinder. Under optimum conditions, expansion is completed in 6·5 msec, and a rapid resetting cycle is also achieved. J. G. WILSON

537.542

1024. Breadth of the cloud chamber tracks of heavily ionizing particles. M. POLLERMANN. *Z. Phys.*, **126** (*Nos* 3–4) 271–80 (1949) *In German.*

α-particles from a weak source entered a cloud chamber through a Geiger counter controlling the chamber, in which expansion could thus be delayed for known intervals after the passage of the particle. The diffusion of ions from heavily ionized tracks was then studied by the photometry of tracks of known diffusion age, and the separation of ion columns in a known electrostatic field was also measured.

J. G. WILSON

537.542 : 539.16.08

Bibliography on radiation detection. *See Abstr.* 1152

IONIZATION . THERMIONICS 537.56/.58

537.581 : 541.11

1025. Application of thermodynamics to chemical problems involving the oxide cathode. A. H. WHITE. *J. Appl. Phys.*, **20**, 856–60 (*Sept.*, 1949).

Computations of the free energy of some chemical reactions involving dissociation or reduction of alkaline earth oxides have been made on the basis of rough estimates of the thermochemical quantities which have not been measured. The resulting values of free energy, equilibrium constant and equilibrium pressure of Ba vapour derived for specified ideal

conditions are tabulated. Several applications of these results are discussed. A.

537.583 : 538.632

Hall effect in oxide cathode coatings. *See Abstr.* 1104

COSMIC RAYS 537.591

537.591

1026. Note on the origin of cosmic rays. D. TER HAAR. *Science*, **110**, 285–6 (*Sept.* 16, 1949).

The hypothesis of Hoyle and others, that cosmic rays arise in supernovae, together with the assumption that a sufficient galactic magnetic field exists to retain charged particles in the galaxy, are examined. It is suggested that the primary emission of the cosmic-ray particles may take place as neutrons at the fission of ejected nuclear matter at supernovae.

J. G. WILSON

537.591

1027. The creation of protons and varitrons by the neutral component of cosmic rays. A. I. ALIKHANIAN, M. I. DEÏON AND V. M. KHARITONOV. *J. Exp. Theor. Phys., USSR*, **19**, 739–48 (*Aug.*, 1949) *In Russian.*

At 3 250 m altitude a block of Pb was screened with an anti-coincidence layer of counters, (*a*). The emergent charged particles not associated with a discharge in (*a*) were passed through further banks of counters and a magnetic field. The results are held to demonstrate that neutral particles give rise to protons and varitrons in Pb. The production of these particles is explained in terms of charge exchange. E. P. GEORGE

537.591

1028. Cosmic-ray experiments at high altitudes over a wide range of latitudes. A. T. BIEHL, H. V. NEHER AND W. C. ROESCH. *Phys. Rev.*, **76**, 914–32 (*Oct.*, 1949).

A number of experiments made in a B-29 aircraft on the properties of cosmic rays are reported. These include the latitude effect of the following, performed along the 80th geographic *W* longitude from 64° geomagnetic *N* to the geomagnetic equator, all at a constant pressure altitude of 30 000 ft (3·10 m of water equivalent): (1) Intensity at the vertical without and with Pb absorber; (2) intensity at 45° *W* and 45° *E* both without and with Pb absorber; (3) total ionization intensity; (4) extensive showers. Also measured at 48° *N* and at the geomagnetic equator were the following: (1) Zenith angle effect both without and with Pb absorber; (2) intensity *vs.* air pressure without and with Pb; (3) extensive showers *vs.* air pressure; (4) local showers. In addition to the above the variation in azimuth of the cosmic-ray intensity was measured with the various telescopes tipped at 22½°, 45° and 67½° to the vertical at an elevation corresponding to 2·35 m of water equivalent at the geomagnetic equator. 2 Pb thicknesses were used, 10 and 20 cm, inserted between the counter trays. These experiments throw new light on the nature of the primary radiation and on the interaction of the primary particles with the matter through which they pass. A.

537.591 : 523.75

Solar flares and the origin of cosmic radiation. *See Abstr.* 670

537.591 : 539.18

1029. Phenomenological treatment on the production of cosmic-ray mesons. S. HAYAKAWA AND J. NISHIMURA. Letter in *Progr. Theor. Phys.*, **4**, 232–3 (*April–June*, 1949).

Assuming the cross-section for energy loss by primary protons in nuclear collisions depends only on the ratio of initial to final energy, the solution of the diffusion equation of the primary nucleons is obtained. The primary spectrum is maintained. From the absorption coeff., parameters in the theory may be determined. E. P. GEORGE

537.591.1

1030. On the nucleon component in cosmic rays. Y. FUJIMOTO AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **4**, 230–1 (*April–June*, 1949).

Energetic nucleons (A) are supposed to produce groups of lower energy nucleons (B) in penetrating showers. The altitude dependence of the "B" group is evaluated and shown to agree with experimental results. One consequence is that protons form only 6% of the "B" group. E. P. GEORGE

537.591.1

1031. Meson background in penetrating shower experiments. G. COCCONI. Letter in *Phys. Rev.*, **76**, 984–5 (*Oct.* 1, 1949).

An arrangement of counters for detecting penetrating showers was operated in a tunnel, under 2 000 g/cm² water equivalent. The shower frequency was $\frac{1}{5}$th of that at sea level, above ground. Measurements on the penetration of the shower particles suggests that the counter arrangement is sensitive to knock-on showers. After correcting for this contribution, the conclusions of a previous paper [Abstr. 3311 (1949)] are modified, the mean free paths of the ionizing component that produces penetrating showers being now given as 160 gm/cm² Pb, 100 gm/cm² C and 120 gm/cm² air. E. P. GEORGE

537.591.1

1032. The disintegration of varitrons. A. O. VAISENBERG. *J. Exp. Theor. Phys., USSR*, **19**, 727–30 (*Aug.*, 1949) *In Russian.*

A mass spectrometer of the Alikhanian type was used with a further bank of counters in delayed coincidence. The mass spectrum of the particles stopping in Pb at 3 250 m altitude, and giving rise to decay products between 1·3 and 7·8 μsec later was investigated. It is claimed that within this time delay, not only do varitrons of mass 220 m_e disintegrate, but also varitrons of significantly greater and smaller masses. E. P. GEORGE

537.591.1

1033. On the measurement of slow neutrons in the cosmic radiation on a B-29 plane. L. C. L. YUAN. Letter in *Phys. Rev.*, **76**, 1268 (*Oct.* 15, 1949).

Earlier measurements of the slow neutron flux using BF_3 proportional counters gave results $\gg$ than those obtained in balloon flights. The difference is attributed to the local production of neutrons in the aircraft, as when the counters were moved from the navigator's cabin to the tail, results in agreement

with the free-space condition attained in balloon flights transpired. E. P. GEORGE

537.591.1

1034. Disintegrations produced by mesotrons. P. I. LUKIRSKIĬ AND N. A. PERFILOV. *Dokl. Akad. Nauk., SSSR*, **61** (*No.* 2) 259–61 (1948) *In Russian.*

Stars observed in a photographic plate, with from 4 to 12 branches, are assumed to be due to the capture and annihilation of negatively charged particles. The masses of these particles are deduced to be $> 200\,m_e$ and various values up to $670\,m_e$ are given. E. P. GEORGE

537.591.1

1035. Cloud chamber photographs of mesons of small mass. J. RÜLING AND R. STEINMAURER. *Experientia*, **5** (*No.* 9) 355–7 (1949) *In German.*

Two photographs in a slow cloud chamber at 2 300 m altitude are considered to provide evidence of particles of mass $< 70\,m_e$ and $>$ that of the electron. One assignment is made on the energy momentum relations at an elastic collision and the other on range-curvature measurements, and both photographs are taken in a field $\sim 2\,000$ gauss.

J. G. WILSON

537.591.1

1036. The τ-meson. N. WAGNER AND D. COOPER. Letter in *Phys. Rev.*, **76,** 449–50 (*Aug.* 1, 1949).

Three tracks in C2 emulsion exposed at 100 000 ft are identified by grain counting as τ mesons. One of these originates in a star of 18 tracks and has a range of 7 000 μ. It ends in a star of two heavy particles. J. G. WILSON

537.591.1

1037. The detection of heavy particles in the primary cosmic radiation. M. A. POMERANTZ AND F. L. HEREFORD. Letter in *Phys. Rev.*, **76,** 997–8 (*Oct.* 1, 1949).

The use of a counter telescope of counters of low efficiency to discriminate between lightly and heavily ionizing particles, and so to establish the presence of particles more highly charged than protons at altitudes $>$ 15 mm Hg, is described. The technique is strengthened by absorption measurements made by the interposition of absorbing layers within the telescopes. Precautions against shower phenomena and local nuclear explosions are considered adequate.

J. G. WILSON

537.591.1 : 523.854.3

1038. Galactic rotation effect and the origin of cosmic radiation. M. S. VALLARTA. *Rev. Mod. Phys.*, **21,** 356 (*July*, 1949).

Points out that if cosmic rays originate outside the galaxy, there will be a diurnal variation of intensity of about 0·2%, and recent improvements in counter technique thus make a crucial expt. possible.

537.591.1 : 539.18

1039. Positive excess of mesons at 30 000 feet. M. CONVERSI. Letter in *Phys. Rev.*, **76,** 311–12 (*July* 15, 1949).

The positive excess of mesons up to momentum about 300 MeV as a function of altitude has been measured up to 30 000 ft at mag. latitudes about 45° by comparing the numbers of delayed coincidences observed in C absorber (all mesons decay) and S absorber (+ only). The results show a +/− ratio 1·24 at sea-level (300 MeV), 0·99 at 2 100 ft (50 MeV) and 1·54 at 30 000 ft (250 MeV). At 30 000 ft the ratio may be augmented by the successive decay of π^+ and μ^+ mesons in the absorber; π^- mesons should be captured in both materials. J. G. WILSON

537.591.15

1040. An interpretation of mixed showers. S. HAYAKAWA. Letter in *Phys. Rev.*, **75,** 1958 (*June* 15, 1949).

The frequent occurrence of more than one cascade axis in mixed showers in the cloud chamber is considered in terms of decay theories of initiation of cascade component and of the charge acceleration process [Abstr. 7133 (1949)]. The observed angular divergence/shower size relation is not favourable to decay processes. The angular divergence also excludes the charge acceleration process for the incident nucleon, and interference effects which may be expected to suppress charge acceleration radiation from created mesons, which are in agreement with the observed presence of single cores only in air showers, must not be effective in the relatively low-energy mixed showers discussed here.

J. G. WILSON

537.591.15

1041. Extensive penetrating cosmic ray-showers. J. ISE, JR. AND W. B. FRETTER. *Phys. Rev.*, **76,** 933–42 (*Oct.* 1, 1949).

The density spectrum of the particles in Auger showers capable of penetrating 20 cm of Pb has been measured at 3 026 m elevation, and found to be very nearly the same as the density spectrum of the soft component of the showers, the ratio of penetrating to soft particles apparently decreasing slowly with increasing shower density. This ratio has been measured, using the coincidences between 4 trays of Geiger counters, all shielded by 20 cm Pb, and found to be about 2·3%. As this value is considerably $>$ the value found by other methods, some calculations on the structure of Auger showers are given, in an attempt to explain the discrepancy. It is found that any experiment using coincidences between unshielded trays, horizontally separated by a few m, is biased strongly toward recording only the cores of the extensive showers. A cloud chamber, tripped by extensive shower counters, is used to study the structure of the extensive showers, and local production of penetrating particles in Pb plates within the chamber is definitely established. A.

537.591.15

1042. A cloud chamber investigation of showers under lead, and of atmospheric showers at a height of 3 860 metres. N. G. BIRGER. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 245–9 (1948) *In Russian.*

A cloud chamber, 15 cm in diameter and containing 3 lead plates, was operated under 20 cm of lead. The showers observed cannot all be knock-on events of the penetrating component. Several events are explained by assuming the simultaneous production of penetrating particles and cascade electron showers. 3 stars were observed in the chamber, one associated with a dense shower. With light material over the chamber, atmospheric showers were observed in the Wilson chamber. The results are discussed.

E. P. GEORGE

537.591.15

1043. An investigation of genetically connected impulses using proportional counters. D. Rakitin and G. Stashkov. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 263–6 (1948) *In Russian.*

A vertical telescope of 4 proportional counters was operated in coincidence with a bank of Geiger counters placed at a distance of 2 m. 3- and 4-fold coincidences in the telescope, not accompanied by a discharge in the Geiger counters, were studied at 3 860 m altitude. Results are reported with various absorbers in the telescope, and are explained in terms of successive nuclear disintegrations in the various banks of proportional counters.

E. P. GEORGE

537.591.15

1044. The formation of cosmic ray showers under heavy layers of lead, at various altitudes. L. V. Kurnosova and B. A. Shulyak. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 6) 1023–6 (1948) *In Russian.*

Showers observed with a system of counters under 13 cm Pb, were found to increase with altitude more rapidly than the hard component. The showers observed cannot therefore be explained as solely due to knock-on showers, and the results are discussed in relation to the penetrating showers observed by others.

E. P. GEORGE

537.591.15

1045. Penetrating particles in extensive atmospheric showers. G. I. Zatsepin, S. A. Kuchai and I. L. Rozental (Rosenthal). *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 1) 47–50 (1948) *In Russian.*

Three trays of counters, with ~ 2 m separation, were each covered with Pb, and the absorption of the particles in extensive showers studied up to 32 cm of Pb, at an altitude of 3 860 m. By using Al in addition, it was observed that electron cascades were detectable up to ~ 20 cm Pb. Thereafter, the absorption was very slow, characteristic of μ-mesons. The mean density of the soft particles in the showers was estimated to be ~ 200 particles/m^2, by recording coincidences with a fourth, unscreened, tray.

E. P. GEORGE

537.591.15

1046. A study of heavy particles in cosmic rays by means of proportional counters. A. N. Gorbunov and I. V. Chuvilo. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 6) 1019–22 (1948) *In Russian.*

Describes a series of experiments in which heavily ionizing particles in cosmic rays are detected by coincidences in 2 proportional counters. A comparison of the frequency of the events at 2 altitudes, together with the frequency under C at the lower altitude is alleged to demonstrate that the primary particles are unstable. The absorption of the primary radiation was measured in C, Al and Pb absorbers at 3 860 m. The cross-section for absorption was found to be $1{\cdot}9(A-Z)^{2/3} \times 10^{-26}$cm^2. The connection between nuclear disintegrations and penetrating showers was investigated by using the proportional counters in coincidence with several arrangements of shielded Geiger counters. The absorption of the particles generated in these showers is found to be $<$ that of the primary particles. E. P. GEORGE

537.591.15

1047. On the transition effect of atmospheric showers. T. Asatiani and N. Shostakovich. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 239–41 (1948) *In Russian.*

Atmospheric showers were studied at sea-level by means of 2-fold and 3-fold counter coincidences. Transition curves, obtained by placing Pb over one of the counters were obtained for a counter separation of 20 cm (narrow showers) and 150 cm (wide showers). Differences in the transition curves are taken to indicate that while the particles in wide showers are mostly electrons, those in narrow showers are not.

E. P. GEORGE

537.591.15

1048. Cosmic-ray bursts under thick shields. Y. Fujimoto, S. Hayakawa and Y. Yamaguchi. Letter in *Progr. Theor. Phys.*, **4**, 233–5 (*April–June*, 1949).

The contributions to be expected from the bremsstrahlung of μ and π mesons, and the charge acceleration of nucleons are evaluated. The contribution from π mesons is small, but nucleon charge acceleration gives 7 times as many bursts as μ mesons. The anomalous increase of bursts under thick shields with altitude is explained by attributing part to the effect of the nucleons. E. P. GEORGE

537.591.15

1049. Exchange phenomena of the nucleons that generate penetrating showers. H. A. Meyer and G. Schwachheim. Letter in *Phys. Rev.*, **76**, 149 (*July* 1, 1949).

The non-exponential absorption of the penetrating-shower-producing radiation described by Cocconi [Abstr. 3311 (1949)] is treated as arising from the sensitivity of his apparatus to charge exchange as well as to absorption by penetrating-shower formation. The deduced ranges for charge exchange, although not accurate, are reasonable. J. G. WILSON

537.591.15

1050. On the penetrating component of cosmic-ray air showers. F. L. Hereford. Letter in *Phys. Rev.*, **76**, 142–3 (*July* 1, 1949).

The presence of highly ionizing particles among the penetrating particles in extensive air showers was investigated using a shielded counter array in which one layer of counters consisted of alternate counters of low efficiency (low total gas pressure) and of normal efficiency. The relative efficiency of the 2 counter types was compared for (1) cosmic-ray mesons, and for (2) the penetrating particles from air showers. Concluded, that highly ionizing particles, if protons, cannot be present to $> 10\%$ of all penetrating particles from showers. J. G. WILSON

537.591.15 : 539.185

1051. Angular distribution and multiplicity of neutrons associated with local cosmic-ray showers. G. Cocconi and V. Cocconi Tongiorgi. Letter in *Phys. Rev.*, **76**, 318–19 (*July* 15, 1949).

A simple penetrating-shower detector (two counter levels only) is surrounded by paraffin which encloses arrays of BF_3 counters above and below the shower detector. The lead shower-generating layer is varied up to 3″ thickness. Observations show that neutron

emission from the lead is substantially isotropic, while the estimated neutron multiplicity at all thicknesses is ~ 10 or greater. J. G. WILSON

537.591.3

1052. A study of the interaction of the primary component of cosmic rays with matter in the stratosphere. S. N. VERNOV. *J. Exp. Theor. Phys., USSR*, **19**, 621–6 (*July*, 1949) *In Russian.*

A hodoscoped tray of counters was placed below a counter telescope containing Pb absorbers. Measurements were made at a height of 30 km using balloons. The results are consistent with the view that the soft component consists mainly of electrons and photons. The investigation of the hard component, and the structure of the showers created by primary particles, lead to the conclusion that the absorption of the primary particles gives rise to an intense electron-photon component. If this component arises from the decay of short-lived mesons, the life-time of the mesons must be $< 10^{-10}$ sec. E. P. GEORGE

537.591.3

1053. The transition effect of cosmic rays in the stratosphere. S. I. BRIKKER, S. N. VERNOV, N. L. GRIGOROV, I. M. EVREINOVA AND T. N. CHARKHCHYAN. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 4) 629–31 (1948) *In Russian.*

Results are given of the counting rate of a single counter screened with 0, 1, 2 and 4 cm Pb at an altitude of 30 km. The results are inconsistent with the assumption that the primary charged cosmic radiation consists exclusively of electrons.

E. P. GEORGE

537.591.5

1054. On the latitude dependence of the absolute neutron intensities in cosmic radiation. L. C. L. YUAN. Letter in *Phys. Rev.*, **76**, 1267–8 (*Oct.* 15, 1949).

The counting rate of a BF_3 proportional counter was measured, with and without Cd shields, at various latitudes in a *B*29 plane flown at 25 000 ft. From the Cd difference, the latitude curve for slow neutrons is obtained. The ratio at latitudes 55° and 20° *N* is found to be 2·9. E. P. GEORGE

537.591.5

1055. Variation of meson intensity with height. P. H. BARKER. Letter in *Phys. Rev.*, **76**, 141–2 (*July* 1, 1949).

The variation with altitude to 30 000 ft of cosmic-ray particles penetrating 5·25 cm Pb is determined at 45° *S* mag. lat. and is compared with similar measurements with 8 cm Pb in India; the results are examined in terms of the latitude effect of the hard component. J. G. WILSON

537.591.5

1056. Changes in cosmic ray intensity associated with air pressure, height of the 100 mb level and magnetic storms. B. TRUMPY. *Bergen Museums Arb.* (*No.* 3) 3–17 (1949) *In English.*

Continuous records of cosmic-ray intensity with a twofold counter telescope containing 8 mm Pb and shielded above with 80 cm Fe + concrete are described for the winter 1948–49 at Bergen, and these are correlated with meteorological conditions and with radio-sonde pressure records. Particular attention is directed to variations of intensity near warm and cold fronts which follows the height of the 100 mb layer closely rather than the air pressure, and limitations in the description of the pressure coeff. of variation of intensity are indicated. Observations of intensity variations associated with magnetic storms Jan. 24–27, 1949, are also described. J. G. WILSON

537.591.5

1057. Latitude dependence at 30 000 feet of penetrating particles slowed down after traversing 15 cm of lead. M. CONVERSI. Letter in *Phys. Rev.*, **76**, 444–5 (*Aug.* 1); Erratum, 1541 (*Nov.* 15, 1949).

The latitude dependence at 30 000 ft (9°*N* to 59°*N*) of particles filtered through 15 cm Pb which (*a*) stop in 10 cm graphite without decay particles of the meson decay period, (*b*) stop with decay product of this period, has been measured. From the two results, the latitude variation of the non-mesonic component is deduced, and, assuming this to be composed of protons, the result is considered in adequate agreement with the latitude variation of stars and small bursts. J. G. WILSON

537.591.5

1058. The zenith angle dependence of flux of the hard cosmic-ray component up to 36 000 feet. J. F. JENKINS, JR. Letter in *Phys. Rev.*, **76**, 992–3 (*Oct.* 1, 1949).

Counter telescopes containing respectively 8 cm and 10 cm Pb, flown up to 36 000 ft and distinguishing shower phenomena by additional counter channels, were used to compare the vertical intensity with that at 45° zenith angle. There is no measurable departure from the $\cos^2\theta$ dependence of counting rate on zenith angle θ until the residual atmosphere is $< 500\ \mathrm{g.cm^{-2}}$. At lower atmospheric thickness the exponent falls linearly to 0 at the top of the atmosphere. J. G. WILSON

537.591.8

1059. Experiments with nuclear-track emulsions sensitive at minimum ionizing power. A. C. COATES AND R. H. HERZ. *Phil. Mag.*, **40**, 1088–93 (*Oct.*, 1949).

The angular distribution of straight-line tracks due to high-energy cosmic-ray particles at sea-level and their number per cm^2 per day at sea-level and below an absorber (equivalent to 60 m of water) were investigated. Slow electron tracks were recorded at the rate of 10^4 per cm^2 per day in a 200 μ-thick emulsion. The sensitivity of the emulsion to particles at min. ionization does not change at low temp. (−80°c), although a decrease of 24%, for X-ray exposures at −80°c, was found. Some pair formation tracks produced by a 25 MeV synchrotron were observed. In most cases one particle stops in the emulsion before slowing down. Elastic collisions and the formation of a multiple star are discussed.

L. S. GODDARD

537.591.8

1060. Nuclear transmutations produced by cosmic-ray particles of great energy. II. Observations at high altitudes by means of free balloons. U. CAMERINI, T. COOR, J. H. DAVIES, P. H. FOWLER, W. O. LOCK, H. MUIRHEAD AND N. TOBIN. *Phil. Mag.*, **40**, 1073–88 (*Oct.*, 1949).

Observations similar to those described in Part I

[Abstr. 6317 (1949)] are recorded for altitudes up to 130 000 ft. These were made with the use of free balloons. At about 75 000 ft the radiation which produces "stars" consists of charged and neutral particles, the directions of motion of which are more widely dispersed than at lower depths in the atmosphere. High energy processes are relatively more frequent than at 11 000 ft, the greatest height studied previously. Estimates are made of the energy of the particles. In 4 of the 7 cases examined, the shower particles were found to be less massive than the proton. Balloon flights give favourable conditions for studying the generation of π-particles in matter in the vicinity of the plates, and for estimating the rate of production of mesons in the energy range below 60 MeV. An event is described which seems to be due to the impact of a Cl nucleus ($Z = 17 \pm 2$) with one of Ag or Br. The primary particle is almost completely dispersed into its component nucleons. Photo-micrographs are given of characteristic examples of the nuclear transmutations discussed. L. S. GODDARD

537.591.8

1061. Investigation by the method of proportional counters of genetically connected impulses, arising from cosmic rays. N. DOBROTIN, S. NIKOLSKY AND V. TSIRLIN. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 249–50 (1948) *In Russian.*

3-fold coincidences were recorded between two proportional counters and one fast counter, in various arrangements. Neither atmospheric showers nor nuclear disintegrations in the surrounding matter are thought to account for the observations. The results are explained in terms of genetically connected disintegrations. E. P. GEORGE

537.591.8

1062. Nuclear effects of very large energy due to cosmic rays. L. LEPRINCE-RINGUET, F. BOUSSER, T. F. HOANG, L. JAUNEAU AND D. MORELLET. *C.R. Acad. Sci., Paris*, **229**, 163–7 (*July* 18, 1949) *In French.*

Two stars observed in Ilford G5 plates flown between 25 and 35 km altitude are described. The first shows 27 heavy tracks and 28 tracks near min. grain density, and no ionizing primary particle, the second 34 heavy tracks and 17 near min. grain density, together with an ionizing primary particle. In the first event, some of the relativistic tracks are ascribed to protons, and the remainder to mesons. The angular distribution of these tracks is stated to preclude the possibility that all the mesons are created in one single act. The primary of the second event is a particle with Z between 14 and 20 and energy of at least 10 BeV. It is likely that no, or very few, mesons are created in this collision, all the relativistic tracks being due to protons. E. P. GEORGE

537.591.8

1063. Frequency of stars of different sizes produced by the cosmic radiation in photographic plates exposed at 29 000 meters. M. ADDARIO AND S. TAMBURINO. Letter in *Phys. Rev.*, **76**, 983–4 (*Oct.* 1, 1949).

The frequencies are given for stars of various sizes, and compared with results obtained at mountain altitudes. The large stars are found to increase more rapidly than the small ones. E. P. GEORGE

537.591.8 : 778.3

1064. The influence of an electric field on the number of nuclear disintegrations observed on photographic plates. P. I. LUKIRSKI AND N. A. PERFILOV. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 257–9 (1948) *In Russian.*

The frequency of stars on a photographic plate maintained at a potential of +5 000 V was compared with that on a control plate at zero potential, but under otherwise similar conditions, at an altitude of 3 250 m. In the size-range, 2 to 5 tracks, the number of stars in 6 cm² of charged plate was 119, whereas on the uncharged plate was 59. The difference is attributed to disintegrations produced by negative mesons attracted by the positively charged plate. E. P. GEORGE

MAGNETISM 538

538.082 : 550.38

1065. Airborne magnetometer for measuring the earth's magnetic vector. E. O. SCHONSTEDT AND H. R. IRONS. *Science*, **110**, 377–8 (*Oct.* 7, 1949).

538.082.74

1066. Inductance apparatus for diamagnetic measurements. S. BROERSMA. *Rev. Sci. Instrum.*, **20**, 660–3 (*Sept.*, 1949).

Two types of inductance apparatus have been applied to the measurement of the susceptibility of diamagnetic compounds. With an alternating current apparatus, an accuracy of 0·1% of the diamagnetic effect, $\Delta\kappa = 0{\cdot}7 \times 10^{-8}$, has been obtained. The time of measurement was about 8 min. Liquids could be easily measured; solids would give no difficulties. In an apparatus with varying coeff. of inductance, the effect of a moving substance in a magnetostatic field was investigated. To date, its precision is a factor of 10 smaller than that obtained with the first apparatus. A.

538.083.9

1067. On the determination of the permeability of plate-shaped materials at centimeter wavelengths. E. LEDINEGG. *Öst. Ingen. Arch.*, **3** (*No.* 4) 325–7 (1949) *In German.*

The usual method for experimental determination of permeability (μ) by concentric Lecher-lines fails for small μ-values. The cavity-method described permits the exact determination of the permeability of circular, plate-shaped samples in this region. A.

538.11 : 531.51 : 530.1

Theory of the relations between gravitation and electromagnetism. *See Abstr.* 694–5

538.114

1068. Statistics of the three-dimensional ferromagnet. T. OGUCHI. Letter in *Phys. Rev.*, **76**, 1001 (*Oct.* 1, 1949).

The three-dimensional Ising problem is formulated by extending the screw method of Kramers and Wannier [Abstr. 2412 (1941)]. The partition function and magnetization are obtained in low temperature

series form, more accurate than the approximate results of Takagi [Abstr. 1116, 2449 (1941)], from which they differ in terms $\exp(-16J/kT)$, J being the exchange energy. Calculations are also carried out for a 2-dimensional hexagonal lattice.

E. P. WOHLFARTH

538.22

1069. Magnetic study of some hydrates. M. PRASAD, S. S. DHARMATTI, C. R. KANEKAR AND N. S. BIRADAR. *J. Chem. Phys.*, **17**, 813–18 (*Sept.*, 1949).

Magnetic susceptibilities of a number of hydrates have been measured by the Gouy technique. In several hydrates of the same salt it has been found that the deviation in the observed molecular susceptibility from additivity, per molecule of water of crystallization, is greatest in the hydrate containing the least number of molecules of water of crystallization and tends to decrease as the number of molecules of water of hydration increases. A relation has been shown to exist between the heat of hydration per molecule of water of crystallization and the deviation in χ_m per molecule, in these hydrates. The departure from the additivity rule in hydrates has been explained on the basis of bindings between the molecules of water of crystallization and the anhydrous salt. A.

538.22

1070. The magnetism of $K_2S_nO_6$ compounds. U. CROATTO, V. SCATTURIN AND A. FAVA. *Ric. Sci.*, **19**, 700–3 (*July*, 1949) *In Italian.*

Salts of composition $K_2S_nO_6$ show a change in molecular susceptibility of $9{\cdot}1\times10^{-6}$ between the di- and trithionates. Between the tri- and tetra- and the tetra- and penta-, the change is $17{\cdot}6\times10^{-6}$. This is suggestive in regard to structure and tends to confirm the Partington–Vogel hypothesis and invalidates earlier proposals. N. F. ASTBURY

538.22

1071. Magnetic properties of metal single crystals at low temperatures. D. SHOENBERG. Letter in *Nature, Lond.*, **164**, 225–6 (*Aug.* 6, 1949).

The de Haas–van Alphen effect (periodic variation of susceptibility with magnetic field) has been found in Ga, Sn and graphite single crystals.

D. SHOENBERG

538.22

1072. The magnetic behaviour of an anisotropic metal cylinder. A. R. FRASER AND D. SHOENBERG. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 680–3 (1949).

The magnetic behaviour of an anisotropic metal cylinder in an alternating magnetic field parallel to the cylinder axis is discussed. It is shown that provided the anisotropy is not too great, the cylinder behaves as if it were isotropic with a specific resistance equal to the arithmetic mean of the extreme values in a plane perp. to the cylinder axis. D. SHOENBERG

538.22

1073. Variation of moment and Curie temperature of palladium hydrides. J. WUCHER. *C.R. Acad. Sci., Paris*, **229**, 175–7 (*July* 18, 1949) *In French.*

Curie constants of Pd–H system, like the susceptibilities, show a linear dependence upon the atomic ratio H/Pd. The Curie constant and susceptibility are zero for H/Pd = 0·65, suggesting a defect of this order in the 4*d* shell of the Pd atom.

N. F. ASTBURY

538.221 : 669

1074. The importance of ferromagnetic properties for the study of alloys. C. GUILLAUD. *Rev. Métall.*, **46**, 453–6 (*July*, 1949) *In French.*

Indicates the significance of thermomagnetic behaviour and saturation moments in relation to phase changes of binary systems. N. F. ASTBURY

538.221

1075. On the gyromagnetic ratio and spectroscopic splitting factor of ferromagnetic substances. C. KITTEL. *Phys. Rev.*, **76**, 743–8 (*Sept.* 15, 1949).

A discussion is given of the connection between the results of microwave resonance absorption experiments and gyromagnetic ratio experiments on ferromagnetic substances. A review of the experimental data indicates that the microwave experiments usually give $g > 2$, while gyromagnetic measurements usually give values of the related quantity g' which are < 2. The analogous situation obtaining in paramagnetic salts is explained by means of a simple example, and the application of the argument to ferromagnetic substances is indicated. The validity of the use of g in the macroscopic equations of motion in the resonance experiment is justified as a consequence of the approximate mutual cancellation of the orbital and lattice angular momenta. A critical discussion is given of other attempts to explain the $g \neq g'$ effect. A.

538.221

1076. Coercive force and crystallite size. F. BERTAUT. *C.R. Acad. Sci., Paris*, **229**, 417–19 (*Aug.* 8, 1949) *In French.*

Coercive force of Fe powders prepared at different temps. by H reduction of the formate show marked peak ($\sim$ 1 000 gauss) for size, about 200 Å. This is generally in accord with Néel's views on shape anisotropy and the results suggest a critical size below which the Fe crystallites behave paramagnetically, but traces of Fe_2O_3 may complicate the interpretation. N. F. ASTBURY

538.221

1077. Ferromagnetic resonance absorption in magnetite. L. R. BICKFORD, JR. Letter in *Phys. Rev.*, **76**, 137–8 (*July* 1, 1949).

Earlier results with natural crystals are confirmed by measurements with synthetic single crystals in the form of thin circular discs forming part of the wall of a rectangular resonant cavity. Specimen values of the first order anisotropy coeff. and the *g*-factor are given for the 3 cm and 1 cm wavelength regions, at temps. above and below −143°C where the material is shown to be magnetically isotropic.

G. F. HODSMAN

538.221

1078. Variation of the coercive force of reduced nickel between −253°C and 150°C. L. WEIL. *C.R. Acad. Sci., Paris*, **228**, 1581–2 (*May* 16, 1949) *In French.*

In finely powdered Ni at 150°C the magnetic anisotropy (K) is zero and H_c arising only from shape anisotropy, varies with temp. only propor-

tionally to J_s. As the temp. falls K increases and between liquid air and liquid H temps. the shape anisotropy becomes negligible. Measurements show that in this range H_c increases in almost exact $\propto K/J_s$. C. E. WEBB

538.221 : 523.51

1079. Temperature dependence and temperature hysteresis of the magnetic anisotropy of meteorite iron. L. V. KIRENSKIĬ. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 2) 191–4 (1949) *In Russian.*

The material was from "Boguslavka" meteorite (fallen near Nikolsk-Ussurisk in 1916). The investigation was carried out on a disc-shaped specimen, by the method of automatically photo-recorded magnetograms of the magnitude of the mechanical moments applied to the specimen in a homogeneous mag. field by means of Akulov's anisometer. The temp. range of the investigations was between −183°C and 800°C, the field applied 11 750 oersted for ensuring saturation. Between 0° and 550°K the curve satisfies the relation $k = k_0 \exp(-\alpha T^2)$ given by N. L. Bryukhatov and the author [*J. Exp. Theor. Phys.*, **8**, 198 (1938)]. Above 550°K the phenomena are more complex, partly owing to recrystallization processes. B. F. KRAUS

538.222

1080. The principal magnetic susceptibilities of single crystals of rare earth salts at low temperatures. I. Cerium salts. A. MOOKHERJI. *Indian J. Phys.*, **23**, 217–28 (*May*, 1949).

The principal susceptibilities of Ce salts have been measured from room temp. down to liquid air temp. The results are discussed in terms of the theory of crystalline field. It has been found that (1) the deviation of the effective mean square moment of the Ce^{+++} ion, from the Hund value for the free ion can be explained on the assumption of a single suitable cubic field, which is the same at all temps. in the range studied; (2) the mean square moment is determined almost wholly by the cubic part of the field, the rhombic part has very little effect on it; (3) the variation in the magnitude of the cubic field as we pass from hydrated salts to anhydrous halides is found to be in the proper direction; (4) the χ_1–axis of $CeNH_4(SO_4)_2\ 4H_2O$ crystal rotates by about 15° as the temp. is lowered from 300°K to 85°K. A.

538.222

1081. On the complex magnetic susceptibility of a paramagnetic at high frequencies. I. G. SHAPOSHNIKOV. *J. Exp. Theor. Phys., USSR*, **19**, 577–80 (*July*, 1949) *In Russian.*

The author's thermodynamic theory of paramagnetic relaxation [Abstr. 3829 (1948), 5568 (1949)] is used for calculating the dependence of the real and imaginary parts of the susceptibility of an ideal paramagnetic (spin-only magnetism) on the magnitude of a transverse steady field, for the case of frequencies high compared with the reciprocal of the spin-spin relaxation time. The experimental data are compared with the theory. D. SHOENBERG

538.222

1082. A magnetic study of sulphur vapour. A. B. SCOTT. *J. Amer. Chem. Soc.*, **71**, 3145–7 (*Sept.*, 1949).

The molar susceptibility of S_2 at temps. between 550 and 850° has been measured and found to agree with the theoretical value within the limits of experimental error. The existing equilibrium data predict satisfactorily the proportion of S_2 in S vapour between 550 and 850°. A.

538.222 : 535.371

1083. Photomagnetism. Determination of the paramagnetic susceptibility of a dye in its phosphorescent state. G. N. LEWIS, M. CALVIN AND M. KASHA. *J. Chem. Phys.*, **17**, 804–12 (*Sept.*, 1949).

The molar paramagnetic susceptibility of acid fluorescein dye in its 2-sec phosphorescent state in boric acid glass at 25°C has been measured directly by means of a modified Theorell microbalance. The steady state concentration of phosphorescent state molecules was $1{\cdot}96\times10^{-8}$ mole per cm length of sample, calculated from optical intensity integrals and phosphorescence saturation curve data. The calculated value of the molar paramagnetic susceptibility is $3\,090\times10^{-6}$ c.g.s. units, which agrees with the measured value for the susceptibility of the $^3\Sigma$ ground state of O within the estimated max. experimental error of 13%. A.

538.224

1084. Temperature dependence of susceptibility of zinc, cadmium, and gamma-brass. J. A. MARCUS. *Phys. Rev.*, **76**, 621–3 (*Sept.* 1, 1949).

The temp.-dependence (14°K–373°K) of the diamagnetic susceptibility of Zn and Cd single crystals and several polycrystalline γ-brasses has been investigated. For Zn, pronounced maxima occur in the susceptibility parallel to the hexagonal axis ($\chi_{||}$) at 40°K and 105°K, and minima occur at 60°K and 180°K. The susceptibility perpendicular to the hexagonal axis ($\chi_\perp$) is independent of temp. from 14°K to 100°K and then decreases linearly as the temp. is increased. For Cd, $\chi_{||}$ decreases by a factor of 3 between 14°K and 373°K while $\chi_\perp$ increases by 7% in the same temp. interval. Measurements on polycrystals of Cu–Zn alloys in the γ-phase show that the temp. coeff. of susceptibility changes from positive to negative as Cu content is increased, in agreement with previously reported measurements above room temp. At the Cu-rich end of the phase, the susceptibility increases by 10% between 14°K and 293°K; at the Zn-rich end of the phase, the susceptibility decreases by 3% in the same temp. interval. A.

538.24

1085. On the influence of tensile stress on the spontaneous magnetization of nickel near the Curie point. K. P. BELOV. *J. Tech. Phys., USSR*, **19**, 661–6 (*June*, 1949) *In Russian.*

Experimental demonstration of the influence of elastic extension on the magnitude of the spontaneous magnetization of Ni, which becomes particularly marked in the region of the Curie point. This effect, by sign and order of magnitude, corresponds to the observed anomaly on the thermal expansion of Ni in the Curie point. The experimental results can be used for studying, and as an indirect confirmation of the existence of, the magnetostriction of the Ni-para-process. B. F. KRAUS

538.245

1086. Anisotropic permanent magnet alloys. K. HOSELITZ AND M. MCCAIG. Letter in *Nature, Lond.*, **164**, 581–2 (*Oct.* 1, 1949).

Behaviour of b.c.c. "Alcomax" is explained if the easy direction of magnetization coincides with a cube edge, the symmetry being due mainly to demagnetization energy of heterogeneous aggregates of cubic symmetry small enough to form single domains. On cooling in a magnetic field, this symmetry is disturbed by the superposition of a uniaxial term with its easy axis in the preferred direction.

N. F. ASTBURY

538.245

1087. Initial magnetization of a single crystal of the compound Mn_2Sb along the axes of easy and difficult magnetization. C. GUILLAUD, R. BERTRAND AND R. VAUTIER. *C.R. Acad. Sci., Paris*, **228**, 1403–5 (*May* 2, 1949) *In French.*

Describes measurements of initial magnetization and coercive force on a single crystal of Mn_2Sb similar to those previously made on Co [see Abstr. 2614 (1949)]. Directions of easy and difficult magnetization are interchanged at −33°C. Magnetization along a difficult axis occurs by rotation of domain magnetization and values of a in Rayleigh's law deduced from experimental results agree well with calculated values except when the anisotropy is small and internal stress effects become important. Magnetization along an easy axis occurs by boundary displacements—values of a and b are determined, but a definite comparison with theory is not possible.

C. E. WEBB

538.245

1088. Influence of thermal fluctuations on the magnetization of very fine ferromagnetic particles. L. NÉEL. *C.R. Acad. Sci., Paris*, **228**, 664–6 (*Feb.* 21, 1949) *In French.*

Derives, on the basis of shape and crystalline anisotropy [see Abstr. 3259, 3260 (1947)], an expression for the probability of spontaneous reversal of magnetization in a particle, small enough to constitute a single domain, as a result of elastic deformation arising from thermal agitation. It is shown that stable remanent magnetization is only to be expected in particles > 160 Å in dia. A law is derived for the development of the magnetic moment of an assemblage of particles when a constant field is applied. The properties deduced are consistent with those observed in bricks, earthenware and lava and explain the characteristics of thermo-remanent magnetization.

C. E. WEBB

538.245

1089. Influence of thermal fluctuations on the magnetization of solid ferromagnetic materials. L. NÉEL. *C.R. Acad. Sci., Paris*, **228**, 1210–12 (*April* 4, 1949) *In French.*

Applies a treatment, similar to that previously applied to the magnetization of fine particles [see preceding Abstr.], to the displacement of Bloch boundary walls in solid materials. The results obtained are generally similar.

C. E. WEBB

538.247 : 621.317.42 : 621.318.25

1090. Magnetometric measurement of the demagnetization curves of permanent magnets. E. STEINGROEVER. *Arch. Elektrotech.*, **39** (*No.* 6) 391–4 (1949) *In German.*

The determination of the demagnetization curve by 4 magnetometric measurements on a single sample is indicated. The values of the magnetometric demagnetizing factors for l/d from 0·1–1·0 are estimated. For plotting the curve a new kind of B–H and I–H diagram is described.

A. E. DE BARR

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

1091. Maxwell's equations in matter, and their foundation in electron theory. F. SAUTER. *Z. Phys.*, **126** (*Nos* 3–4) 207–23 (1949) *In German.*

The physical significance of the symbols in the equations is analysed by a method more satisfactory than that usually employed.

P. M. DAVIDSON

538.3 : 771.53

1092. Photochemical effects produced by Maxwell's currents. J. ZAHRADNÍČEK. *Publ. Fac. Sci. Univ. Masaryk* (*No. C1*) 3–16 (1948) *In Czech.*

Gives a series of photographs produced by means of currents passing through a condenser, voltage $\sim 10^4$ V, frequency $\sim 10^2$–10^6 c/s and intensity of some mA. Different objects in the form of plates have been put into the field of the condenser, e.g. paper, glass, wood, a leaf or a layer of air, etc. The kinetic energy of ions or electrons in the current is changed into photochemical energy on the photographic plate as long as the energy of an electric particle $\geqslant 2 \cdot 10^{-12}$ erg, i.e. 1 eV.

A.

538.31

1093. The movement of small metal particles having six degrees of freedom in air around a wire carrying a constant electric current. J. A. SCHEDLING. *Phys. Rev.*, **76**, 843–5 (*Sept.* 15, 1949).

538.31

1094. On Barlow's experiment. M. M. RAMÍREZ. *Euclides*, **9**, 142–5 (*April–May*, 1949) *In Spanish.*

A circular metal disc, free to turn round a perpendicular axis through its centre, is partly placed between the two poles of a magnet, with the axis of the disc in the direction of the magnetic field. The arrangement is similar to that used for magnetic braking in electric meters. If an electric potential is applied between the centre of the disc and a point of the periphery of the sector lying across the path of the magnetic field, a torque is produced and the disc begins to rotate. This is known as Barlow's experiment. The electrical conditions and the mechanical forces set up in this arrangement are treated in detail mathematically for a.c. and d.c., and the results are discussed.

H. NOREL

538.541 : 621.3.014.1

1095. The induction of electric currents in non-uniform thin sheets and shells. A. T. PRICE. *Quart. J. Mech. Appl. Math.*, **2**, 283–310 (*Sept.*, 1949).

General equations are obtained for the induction of

electric currents in any thin-sheet distribution of conducting material by periodic or aperiodic fields. Methods of solving the equations for non-uniform plane sheets and spherical shells are considered. Numerical calculations for a special case of the plane sheet are made to illustrate some important features. The case of the spherical shell is considered in some detail, with a view to geomagnetic applications. Methods of approximating to the solution when the conductivity is given as an empiric function are described. A.

538.566 : 535.222

1096. Velocity of electromagnetic waves. C. I. Aslakson. Letter in *Nature, Lond.*, **64**, 711–12 (*Oct.* 22, 1949).

The radar method "Shoran" has been used for the measurement of geodetic distances. The aeroplane flies across the line between two ground stations and the min. sum-distance is determined. Corrections are made for the velocity from psychrometric data, and the distances reduced to the sea-level or geodetic value. 47 lines varying from 67 to 367 miles were measured. The velocity assumed (in vacuo) is 299 776 km/s, and systematic differences were observed between the Shoran lengths and those determined by triangulation. If the results are used to determine velocity the value found is 299 792 ± 2·4 km/s, confirming the high values found by Essen, Bergstrand and Jones and Cornford.

L. ESSEN

538.566 : 535.222 : 621.396.11

Can the velocity of propagation of radio-waves be measured by Shoran? *See Abstr.* 820

538.566 : 535.42

1097. Diffraction of electromagnetic waves by a perfectly conducting plane screen. J.-P. Vasseur. *C.R. Acad. Sci., Paris*, **229**, 179–81 (*July* 18, 1949) *In French.*

The correct solution in integral equations is given following the work of Copson [Abstr. 2575 (1946)] and Bethe [Abstr. 524 (1945)]. A. H. W. BECK

538.566 : 535.42 : 621.396.11

1098. On the diffraction of an electromagnetic wave through a plane screen. J. W. Miles. *J. Appl. Phys.*, **20**, 760–71 (*Aug.*, 1949).

The diffraction of a plane perforated screen is calculated, and the power transferred cast in a variational form of the Schwinger type. An aperture impedance is defined, with real and imaginary parts, and an analogous obstacle admittance. The results are applied to diffraction through a slit and a circular aperture. A.

538.566.2

1099. The propagation of electromagnetic waves through a stratified medium and its W.K.B. approximation for oblique incidence. H. Bremmer. *Physica*, **15**, 593–608 (*Aug.*, 1949) *In English.*

The plane-wave solution of Maxwell's equations for a stratified medium is split into a series of terms; with a simple physical meaning, the first of which constitutes the W.K.B. approximation. The original vector problem is reduced to a scalar problem by introducing a convenient Hertzian vector. The application of the saddle-point method to the individual terms of the series mentioned leads to simple geometric-optical approximations. A.

538.566.2

1100. The propagation of electromagnetic waves in a tube containing a coaxial d.c. discharge. P. Rosen. *J. Appl. Phys.*, **20**, 868–77 (*Sept.*, 1949).

The boundary value problem involved in finding the propagation characteristics of electromagnetic waves in a cylindrical tube containing a coaxial d.c. discharge is solved. Ohm's law is assumed to hold for the alternating current. This assumption has been verified theoretically for the case where the alternating electric field is small compared with the d.c. field. Curves which give the relationship between the complex propagation constant, γ, and the complex permittivity, K'_c, have been computed for the solution in which the TEM mode of the coaxial line is approached as K'_c becomes infinite. A.

MAGNETIC EFFECTS 538.6

538.61

1101. Optical constants of ferromagnetics. S. V. Vonsovski and A. V. Sokolov. *J. Exp. Theor. Phys., USSR*, **19**, 615–20 (*July*, 1949) *In Russian.*

Using a model in which interacting "internal" 3*d* and "external" 4*s* electrons are considered as responsible for the ferromagnetism, the dielectric constant, conductivity and hence the optical properties are calculated for the limiting cases of high and low frequencies. These properties are found to depend on the magnitude of the spontaneous magnetization. The theory for low frequencies agrees with experimental data close to the Curie point.

D. SHOENBERG

538.612 : 535.515

The magnetic double refraction of liquid mixtures. I. Benzene in various solvents. *See Abstr.* 903

538.612 : 535.515

On the theory of the magnetic double refraction in non-polar liquids. *See Abstr.* 904

538.613

1102. Magneto-optic rotation of hydrocarbons. E. G. Foehr and M. R. Fenske. *Industr. Engng Chem.*, **41**, 1956–66 (*Sept.*, 1949).

The magneto-optic rotation and dispersion of various classes of hydrocarbons have been measured. Particular emphasis is given to the hydrocarbons in the molecular weight range of 250 to 450. An effort is made to indicate the limitations imposed upon the use of magneto-optic rotation methods for the analysis of binary mixtures. Certain parameters are developed for the prediction of the rotation of individual members in homologous series of hydrocarbons. A.

538.614

1103. Magneto-optical phenomena in ferromagnetics. S. V. Vonsovskiĭ and A. V. Sokolov. *J. Exp. Theor. Phys., USSR*, **19**, 703–8 (*Aug.*, 1949) *In Russian.*

The quantum theory of the interacting internal and external electrons of the ferromagnetic supplies a general explanation of the rotation of the plane of

polarization and of the elliptic character of the polarization of light passing through a ferromagnetic and reflected at the surface of a magnetized ferromagnetic mirror. Angle of rotation of plane of polarization and ellipticity of the light always vary as the intensity of the technical magnetization of the specimen, the proportionality factors being functions of the spontaneous magnetization. B. F. KRAUS

538.632 : 537.583

1104. Hall effect in oxide cathode coatings. D. A. WRIGHT. Letter in *Nature, Lond.*, **164,** 714–15 (*Oct.* 22, 1949).

The Hall effect was measured for oxides sprayed on a magnesia base. For Ba–SrO σ below 850°K is *P* type (hole conductivity) and $\log \sigma$ and $\log R$ have activation energies of 0·7 eV. Above 850°K σ is *N*-type and $\log \sigma \propto 0{\cdot}8/T$. For BaO similar results are obtained. It is concluded that there are two conduction mechanisms in parallel: (1) through the coating crystals, *P* type; (2) over the crystal surfaces and through the interstices, *N* type. The density of donors would be about 4 orders of magnitude > that of acceptors. A. H. W. BECK

538.652

1105. Longitudinal magnetostriction of nickel and magnesium ferrites. R. VAUTIER. *C.R. Acad. Sci., Paris,* **229,** 177–9 (*July* 18, 1949) *In French.*

Reports measurements on ferrites based on 50% Fe_2O_3. Ni ferrites generally show − coeffs., increasing in magnitude with NiO content. Mg ferrites show much lower + coeffs. The former reach about -20×10^{-6}, the latter $+5\times10^{-6}$.

N. F. ASTBURY

538.66

1106. Investigation of the thermo-magnetic Nernst effect in the silicon iron crystal and in the alloy Ni_3Mn. R. G. ANNAEV. *Dokl. Akad. Nauk, SSSR,* **67** (*No.* 1) 41–4 (1949) *In Russian.*

The paper is concerned with even and odd effects in simple anisotropy and with the thermo-magnetic Nernst effect and gives the fundamental relations for these effects in simple anisotropy. The experimental investigation of a mono-crystal (4% Si + 96% Fe) shows a complete agreement with the calculated value for the applied value of the field $H = 14\,000$ oersted. The results confirmed the expectation that the Nernst constant and the thermo-magnetic effect depend on the percentage of the ordered phase in the alloy.

B. F. KRAUS

538.66

1107. Thermo-remanence and the theory of metamagnetism. E. THELLIER. *C.R. Acad. Sci., Paris,* **223,** 319–21 (*Aug.* 12, 1946) *In French.*

Suggests that certain materials such as α-Fe_2O_3 possess the properties of Becquerel's "metamagnetics" [see Abstr. 1394 (1939)], and that a single theory should account for both. In particular, this theory should explain the facts of thermo-remanent magnetization which appear to demand a mechanism for immobilizing the elementary moments below a temp., θ, which may vary greatly from point to point in the material. C. E. WEBB

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

1108. On Grüneisen's constant for metals. A. KÓNYA. Letter in *J. Chem. Phys.*, **17,** 837 (*Sept.*, 1949).

Grüneisen's constant calculated on Gombás' theory of metals [see Abstr. 1918 (1946)] agrees well with experimental values in the case of the alkali metals. A. E. DE BARR

MOLECULAR STRUCTURE 539.13

539.132

1109. Remarks on intra- and inter-molecular migration of excitation energy. J. FRANCK AND R. LIVINGSTON. *Rev. Mod. Phys.*, **21,** 505–9 (*July,* 1949).

Examples of the 3 processes by which migration of excitation energy can occur—viz. electron migration, exciton migration, or sensitized fluorescence—are given and methods of distinguishing between them are reviewed. There is no confirmation of the supposition that proteins have a special quality for the transmission of energy. A. J. MEE

539.132

1110. The theory of homogeneous spontaneous ortho-para transitions of hydrogen at low temperatures. A. A. ABRIKOSOV. *J. Exp. Theor. Phys., USSR,* **19,** 851–3 (*Sept.*, 1949) *In Russian.*

Although at room temp. ortho-para concentration is 3 : 1, the energetically lowest state has a rotational quantum number $J = 0$, i.e. is para. If at any temp. the concentration is not in equilibrium this tends to be established, at high temps. with the aid of heat dissociation. At low temps., i.e. for liquid and solid H, it has been shown experimentally that the rate of change of ortho-concentration c is $\propto -c^2$. This rate does not alter with increase in temp. so that the activation energy is lacking. The reaction is explained by magnetic exchange effects of 2 ortho-molecules, as a result of which *o–p* transformation takes place in one or both. Exchange energy is expanded in $1/R$ (R = intermolecular distance), leading to a term V_1 in R^{-3}, V_2 in R^{-4}. V_1 gives no transitions, V_2 describes those of one molecule due to a magnetic dipole at centre of the other. Calculating the probability ω of transition per unit time leads again to a law of rate of change of concentration $\propto -\omega c^2$. Magnetic exchange effects therefore explain transitions at low temps. if number of pairs of ortho-molecules is Nc^2 (N = total number of H molecules). In the solid state this is multiplied by an exponential time variation. J. JACOBS

539.132

1111. On the orientation of electron moments of the halide atom in molecules of type ClCN and $ClCH_3$. A. A. Abrikosov. *J. Exp. Theor. Phys., USSR*, **19**, 853–5 (*Sept.*, 1949) *In Russian.*

Mathematical. The exchange field with the quadrupole moment of the nucleus is assumed the same whether an atom is free or bound in a molecule. If in a molecule the electron moment orientations have differing probabilities which may be estimated from the hyperfine structure of the molecular rotation spectrum and the atomic hyperfine structure of haloids. This latter is described by magnetic exchange effects of nucleus and electrons and by quadrupole exchange effects which alone are here discussed. Hyperfine structure of atomic terms is calculated remembering that the electron moment is more strongly coupled to spin than to the quadrupole moment. Correspondingly the expression for the hyperfine structure of the molecular rotation spectra is established from which the probability of the electron moment M of Cl atom in the molecule is obtained. This shows a strong preference for $M = 0$. For Br and I the measurements of hyperfine structure are not exact enough to allow predictions of orientations beyond saying that with increasing atomic number the probability of $M = 0$ increases.

J. JACOBS

539.132

1112. On the detection and determination of redundant vibrational coordinates. C. E. Sun, R. G. Parr and B. L. Crawford, Jr. Letter in *J. Chem. Phys.*, **17**, 840 (*Sept.*, 1949).

An extension of Wilson's *G*-matrix technique for the treatment of molecular vibrations, for use with a redundant set of (i.e. non-independent) valence force co-ordinates. D. H. WHIFFEN

539.132

1113. Resonance energies of the benzyl radical, cation and anion by the method of molecular orbitals. J. G. M. Bremner. Letter in *Research, Lond.*, **2**, 444 (*Sept.*, 1949).

Solution of the secular equation for the benzyl structure shows that the total π-electron energy is the same for the anion, radical and cation, and is computed as 49 kg.-cal. The furfuryl and fulvene structures are briefly considered. W. R. ANGUS

539.132

1114. Orientation [of organic molecules] by Van der Waals forces. J. H. de Boer. *Ned. T. Natuurkde.*, **15**, 205–15 (*Sept.*, 1949) *In Dutch.*

A general discussion is given and application made to the anisotropy of certain organic molecules, both of the long chain type and of the layer lattice type.

E. P. WOHLFARTH

539.132

1115. A modification of the molecular orbital method: the LCMO method. M. J. S. Dewar. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 638–47 (1949).

The secular determinant is simplified by dividing the molecule into components. A superposition of the LCAO molecular orbitals of these parts is the eigenfunction for the whole system. This leads to the same secular equation as the LCAO method does. Energies and coeffs. of wave functions are calculated for some hydrocarbons, neglecting overlap and treating all C atoms as equivalent. J. JACOBS

539.132

1116. Repulsive interaction potentials at small interaction distances: He–He and H–H_2 systems. I. Amdur. Letter in *J. Chem. Phys.*, **17**, 844–5 (*Sept.*, 1949).

Comparison of formulae from scattering expts. and the theoretical formulae for the repulsive potential of He–He leads to a best fit when $r > 0{\cdot}52$ Å and

$$V(r) = [7{\cdot}70 \exp(-4{\cdot}60r) - 5{\cdot}60 \exp(-5{\cdot}33r) - 0{\cdot}68 \exp(-4{\cdot}50r^2)] \times 10^{-10} \text{ erg.}$$

For H–H_2 experimental data corrected for effective angular aperture give

$$V(r) = [0{\cdot}567 \exp(-24{\cdot}9r^2) + 0{\cdot}215r \exp(-2{\cdot}40r^2)] \times 10^{-10} \text{ erg.}$$

D. H. WHIFFEN

539.132

1117. Excited electronic levels in conjugated molecules. III. Energy states of naphthalene. J. Jacobs. *Proc. Phys. Soc., Lond. A*, **62**, 710–21 (*Nov.*, 1949).

The electronic states of naphthalene are determined using antisymmetrized molecular orbitals, which are based on wave functions given by the simple molecular orbital theory. This method allows the electronic interaction term to be included explicitly in the Hamiltonian for the system. A clear distinction is made between electronic configurations determined with these wave functions and the actual states of the molecule: states arise from a superposition of configurations of the same symmetry. The ground state becomes considerably stabilized by this configurational interaction, to which even highly excited levels contribute. Calculated energy values for some of the lower transitions agree well with ultra-violet spectral data, as do the newly derived oscillator strengths. A tentative assignment is made regarding the polarization of the electronic transitions in the region of 30 000–55 000 cm^{-1}. [See Abstr. 1291–2 (1948)]. A.

539.132

1118. Molecular force fields. IX. A relation between bond interactions during vibrations and on dissociation. J. W. Linnett and M. F. Hoare. *Trans. Faraday Soc.*, **45**, 844–55 (*Sept.*, 1949).

539.132

1119. Molecular force fields. X. The bending of double bonds, with particular reference to ethylene and formaldehyde. J. W. Linnett, D. F. Heath and P. J. Wheatley. *Trans. Faraday Soc.*, **45**, 832–44 (*Sept.*, 1949).

539.132

1120. Molecular force fields. XI. A wave-mechanical treatment of the change with distortion of the interaction energy of carbon $2p\pi$ orbitals. P. J. Wheatley and J. W. Linnett. *Trans. Faraday Soc.*, **45**, 897–902 (*Oct.*, 1949).

A wave-mechanical calculation, using the Heitler–London–Slater–Pauling approximation, has been carried out in order to discover the change in interaction energy of two C $2p\pi$ orbitals on different

atoms, when the orbitals are rotated relative to one another round two axes perp. to the line joining the two C atoms. It is found that rotation both in the same sense and in opposite senses tends to lower the potential energy. It is suggested that this is one of the factors that results in the out-of-plane vibration frequencies, corresponding to these distortions, being less than the in-plane frequencies of double-bonded molecules. Complete solutions of 4 exchange integrals, which have hitherto been presented only in an approximate form, are given. A.

539.132

1121. Nodal surfaces in molecular wave functions. K. F. HERZFELD. *Rev. Mod. Phys.*, **21**, 527–30 (*July*, 1949).

One-electron molecular orbitals for mobile electrons, subject to the potential energy of a molecular skeleton, are considered. If the atoms are far apart, the orbitals can be built up exactly from $2p$ atomic wave functions. The molecule in natural size is formed by adiabatic approach. It is shown that all the nodal surfaces reach into infinity, if the atoms are all alike, but that closed nodal surfaces may exist, if they are not. It is proved that the number of electrons inclosed in nodal surfaces is invariant against adiabatic change. Nodal surfaces for antisymmetrized molecular orbitals are then discussed. A.

539.133

1122. A proposed simplification in the procedure for computing electric dipole moments. E. A. GUGGENHEIM. *Trans. Faraday Soc.*, **45**, 714–20 (*Aug.*, 1949).

The usual procedure for computing the electric dipole moment of a polar solute in a non-polar solvent from Debye's formulae is unnecessarily complicated. A simpler method is described which incidentally eliminates the need of measuring densities accurately. A.

539.133

1123. Determination of electronic structure of molecules from nuclear quadrupole effects. C. H. TOWNES AND B. P. DAILEY. *J. Chem. Phys.*, **17**, 782–96 (*Sept.*, 1949).

Nuclear quadrupole coupling constants in molecules depend on the nuclear quadrupole moments and the variation in electrostatic field at the nucleus. It is shown that this variation of electric field is usually simply related to the molecular electronic structure, being primarily dependent on the way in which valence electrons fill the lowest-energy p-type orbits. Structural information which can consequently be obtained from known quadrupole coupling constants is discussed. Hybridization of the normal covalent bonds of N, Cl and As with at least 15% s character is clearly shown. The alkali halides appear to be almost purely ionic; the quadrupole coupling data allow no more than 3% covalent character. In addition to molecular structure, some nuclear quadrupole moments are approximately evaluated by use of the theory developed. A.

539.133 : 532.13

1124. Dimensions and intrinsic viscosity of coiled chain molecules in solution. E. D. KUNST. Letter in *Nature, Lond.*, **164**, 535–6 (*Sept.* 24, 1949).

Using different solvents the root mean sq. distance R between the ends of a coil, for polystyrene, is found to be a function of the intrinsic viscosity $\{\eta\}$ and independent of the m.w. For polyisobutylene, assuming complete permeability of the particles, $\{\eta\}$ is $\propto R^2$ in agreement with the experiments.

J. E. CAFFYN

539.133 : 535.515

Dynamical double refraction and the time of relaxation of normal alcohols. *See Abstr.* 905

ATOMIC STRUCTURE . ISOTOPES 539.15

539.15/.16

1125. Apparatus and experimental methods in nuclear physics. H. DÄNZER, H. EWALD, W. GENTNER, F. G. HOUTERMANS, F. KIRCHNER, H. MAIER-LEIBNITZ, H. MARSCHALL, W. PAUL, H. SALOW AND W. WALCHER. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt., Germany*] "*Nuclear Physics and Cosmic Rays, II*," 1–126 (1948) *In German.*

The detection of radiations is first discussed; this deals chiefly with (*a*) the use of Geiger and proportional counters for ionizing radiations, and (*b*) the available methods for measuring neutron densities and currents. Various accelerating equipments are then described (electrostatic generators, cyclotrons and betatrons). There is a detailed account of an electron cyclotron used for model tests in the study of such matters as orbits and focusing. A fairly full account of experimental and theoretical work on the betatron is given, with sections on beam extraction and on magnetic focusing to increase beam intensity. A section dealing with mass spectrographs then follows; a discussion of image errors is the principal feature. Methods for separation of isotopes in small quantities are briefly considered; these comprise (*a*) mass spectrograph, (*b*) separator with cylindrical geometry, with radial electric field and axial magnetic field (collection of heaviest ions only is possible), (*c*) velocity selector, (*d*) diffusion and electrolysis in solid salts. The final section deals at some length (chiefly theoretically) with problems of shielding from fast neutrons and their secondary radiations (slow neutrons and γ-rays).

A. P. FRENCH

539.152

1126. On the Thomas–Fermi–Dirac functions and their tabulation. K. UMEDA. *J. Fac. Sci. Hokkaido Univ.* (*Ser.* 2) **3**, 171–244 (*Aug.*, 1942) *In German.*

The properties of the equation for a neutral atom with the boundary conditions $\psi = 0$, $\partial\psi/\partial x = 0$ at $x = x_0$ are listed and the solutions tabulated for various values of x_0, which is related to the nuclear charge Z. Complete tables of the functions are printed for all integral Z up to $Z = 92$.

G. J. KYNCH

539.152 : 538.224

1127. The diamagnetic susceptibility of the Thomas–Fermi–Dirac atom. K. UMEDA. *J. Fac. Sci. Hokkaido Univ.* (*Ser.* 2) **3**, 246–8 (*March*, 1949) *In English.*

As a test of the validity of the Thomas–Fermi–Dirac atom the diamagnetic susceptibility of the

neutral atom has been evaluated as a function of the atomic number, on using the recently published accurate table [preceding Abstr.] of the Thomas–Fermi–Dirac function. The results are in better accord with the experimental values. A.

539.152.1

1128. The system of stable nuclei. A. H. W. Aten, Jr. Letter in *Science*, **110**, 260–1 (*Sept.* 9, 1949).

"Near-preferred" nuclei with N (number of neutrons) or Z (number of protons) near to the "magic numbers" 20, 50, 82, 126 also have abnormally high stability, and this is used to explain the majority of apparent irregularities in the system of stable nuclei. A. O. STANESBY

539.152.1

1129. Classification of nuclear isomers. P. Axel and S. M. Dancoff. *Phys. Rev.*, **76**, 892–7 (*Oct.*, 1949).

A classification is made on the basis of the forbiddenness of the transitions from the known nuclear isomeric states. The resultant grouping is shown to be in agreement with the Weizsäcker theory of isomerism and with internal conversion theory. The predictions of internal conversion theory are also compared with the experimental values that are available for the isomers considered. A.

539.152.1

1130. On the systematics of nuclei. A. Broniewski. *C.R. Acad. Sci., Paris*, **228**, 916–18 (*March* 14, 1949) *In French.*

A plot of Z against N for stable isotopes of odd Z shows straight lines where successive isotopes are obtained by the addition of 1 proton and 1 neutron, or by 1 proton and 2 neutrons. The magic numbers 20, 50, 82, 126 for neutrons occur at discontinuities in the slopes of the lines, whilst for protons in the middle of the straight lines. The stability of certain isotopes is discussed. B. ROSE

539.152.1

1131. A physical method for the separation of nuclear isomers. A. S. Karamyan and L. I. Rusinov. *J. Exp. Theor. Phys., USSR*, **19**, 651–63 (*July*, 1949) *In Russian.*

Describes a new method for the separation of the nuclear isomers in Br. E. P. GEORGE

539.152.1

1132. Nuclear spin $\frac{1}{2}$ for Te^{123} and isotope shift in the tellurium spectrum. J. E. Mack and O. H. Arroe. Letter in *Phys. Rev.*, **76**, 1002 (*Oct.* 1, 1949).

539.152.1 : 530.145

The future nuclear interaction. *See Abstr.* 717

539.152.1 : 530.145.6

Note on the iterative method in nuclear problems. *See Abstr.* 732

539.152.1 : 530.145.6

An elaboration of the Schrödinger formalism with applications to nuclear physics. *See Abstr.* 733

539.152.1 : 539.172.3

The alpha particle nodel of light nuclei. *See Abstr.* 1218

539.152.1 : 539.181

A new molecular beam resonance method. *See Abstr.* 1237

539.152.2

1133. Nuclear spin 5/2 for $_{40}Zr^{91}$. O. H. Arroe and J. E. Mack. Letter in *Phys. Rev.*, **76**, 873 (*Sept.* 15, 1949).

539.152.2

1134. Nuclear paramagnetism. B. V. Rollin. *Rep. Phys. Soc. Progr. Phys.*, **12**, 22–33 (1948–49).

A review is given of recent theoretical and experimental work, together with a comprehensive list of references. The principle of the radio-frequency resonance method of measurement is described and the nature and magnitude of the resonance effects are considered in detail. Various experimental arrangements depending on the effects produced in a tuned circuit surrounding the specimen by rotating transverse magnetization are discussed, and it is shown how spin-lattice relaxation times have been calculated and measured. The application of paramagnetic resonance for accurate measurement of nuclear moments is described and reference is also made to its importance in low temp. research. G. F. HODSMAN

539.152.2

1135. Hyperfine splitting in paramagnetic resonance. D. J. E. Ingram. *Proc. Phys. Soc., Lond. A*, **62**, 664–5 (*Oct.*, 1949).

An investigation has been made of the hyperfine splitting of Cu^{++} using a crystal of $ZnSO_4(NH_4)_2SO_4 6H_2O$ in which about one Zn ion in every 1 000 was replaced by a Cu ion. Measurements were made at 20°K with 3 cm wavelength radiation, and results are given for various angles between the applied magnetic field and the tetragonal axis of the crystal used. The existence of an isotope splitting and a splitting due to nuclear quadrupole moment is reported. G. F. HODSMAN

539.152.2

1136. Nuclear induction, a phenomenon of beats. C. R. Extermann, P. Denis and G. Béné. *Helv. Phys. Acta*, **22** (*No.* 4) 388–90 (1949) *In French.*

The shape of nuclear induction signals depends on a parameter p, a function of the transversal relaxation time T and the speed of passing to resonance $\partial H/\partial t$. Keeping T constant the relation for $\partial H/\partial t$ is verified, also the decrease of T with increasing concentration. Calculated p curves are used to obtain T for aqueous solutions of known concentrations of chrome alum. J. JACOBS

539.152.2

1137. Nuclear magnetic resonance and the effect of the methods of observation. G. Suryan. Letter in *Curr. Sci.*, **18**, 203–4 (*June*, 1949).

A discussion of the effect of the detecting resonant circuit and its Q factor on nuclear relaxation times. In average conditions with $Q = 10$ the relaxation time on this account is claimed to be 1 sec. D. H. WHIFFEN

539.152.2

1138. The nuclear magnetic moments of D^2, Li^7, and F^{19} studied by the magnetic resonance absorption method. K. Siegbahn and G. Lindström. *Ark. Fys.*, **1**, *Paper* 6, 193–212 (1949) *In English.*

The method for measuring nuclear magnetic moments by magnetic resonance absorption is

discussed. For precision measurements of nuclear magnetic moments, various requirements have to be imposed on different parts of the apparatus. The importance of a suitable magnetic field is particularly stressed. Special attention has been devoted to forming a very homogeneous field in a moderately sized magnet excited by batteries. A two-probe arrangement is adopted which permits direct comparison of different nuclear moments with the protons. To compare the different magnetic moments with that of the proton as a unit, the frequencies of the resonance lines displayed on a double beam oscillograph have been measured accurately against a crystal frequency standard. The nuclear magnetic moments of D, Li^7 and F^{19} have been measured and compared with earlier measurements. The results (uncorrected for the diamagnetic effect) are:

$$\mu_D/\mu_P = 0{\cdot}3070183 \pm 0{\cdot}0000015$$
$$\mu_{Li^7}/\mu_P = 1{\cdot}165827 \pm 0{\cdot}000060$$
$$\mu_{F^{19}}/\mu_P = 0{\cdot}940334 \pm 0{\cdot}000015$$

The diamagnetic correction is discussed. A.

539.152.2

1139. Nuclear magnetic relaxation in metallic copper. N. Bloembergen. *Physica*, **15**, 588–92 (*July*, 1949) *In English.*

The magnetic resonance of both Cu^{63} and Cu^{65} nuclei has been observed in fine Cu powder at 9·5 Mc/s between 1°K and 20°K. The relaxation time T_1 is inversely $\propto$ the temp. and is 0·3 sec at 1·1°K. For Cu^{65} the relaxation time is about 15% < for Cu^{63}. These results are in good agreement with the theory of Heitler and Teller. The line width is about 6 oersteds. This corresponds to a value of T_2 determined only by the other Cu nuclei in the lattice. A.

539.155.2

1140. The electromagnetic separation of the isotopes of mercury. C. P. Keim. Letter in *Phys. Rev.*, **76**, 1270–1 (*Oct.* 15, 1949).

539.155.2

1141. An electromagnetic isotope separator. I. Bergström, S. Thulin, N. Svartholm and K. Siegbahn. *Ark. Fys.*, **1**, *Paper* 11, 281–92 (1949) *In English.*

Ions of constant velocity, accelerated and focused in a 4-electrode lens system, are deflected through 90° at a radius of 160 cm in a 6·5 ton, 8 kW magnet. The accelerating potential is variable from 0–70 kV; with 60 kV and 3 500 gauss the heaviest elements can be separated. The magnetic field current and the primary supply of the high-voltage rectifier are stabilized. In the ion source, an arc discharge (~2 A, 200 V max.) passes between a hot W cathode and a W anode, with an axial magnetic field of 600 gauss max. The pressure is ~0·001 mm. The ion source is oil cooled, and although originally intended for gaseous samples has been used with metals evaporated in a crucible; cathodes and samples may be changed through an air lock. 2 mA of A ions have been produced. Some preliminary metal separations are tabulated, e.g. 50 μg Mg^{24} was collected in 270 min., with a max. deflected current of 100 μA. The 53 day Hg activity was assigned to Hg^{203} by separating a pile-irradiated Hg sample. T. G. Pickavance

539.155.2 : 539.164

Binding energies of alpha-particles in medium heavy nuclides. *See Abstr.* 1166

539.155.44

1142. Determination of atomic and molecular weights by an X-ray method. M. Straumanis. *Z. Phys.*, **126** (*Nos* 1–2) 49–64 (1949) *In German.*

Atomic and molecular weights can be determined by finding the volume of the unit cell and the number of particles making up the cell by X-ray methods. The value obtained is independent of the units in which the wavelength of the X-rays is expressed, but it depends on the value ascribed to the molecular weight of calcspar, which is now taken as 100·095 instead of 100·075, the value used by Siegbahn. The results obtained for the atomic weights of 12 elements by this method agree with those obtained by chemical methods if the lattice constants and density are accurately known. The molecular weights of 7 elements have also been determined by the same method and there is good agreement with chemical values except in the case of rock-salt. The molecular weights of mixed crystals of the substitution type can also be obtained by X-ray methods; the idea of mean molecular weight of a mixed crystal is introduced. Rock-salt and the purest NaCl have different densities (2·16300 and 2·16076 g/cm^3, respectively). Rock-salt is a supersaturated mixed crystal with separations. Calcspar on the other hand is a pure substitution mixed crystal. A. J. Mee

539.155.4

1143. Further source of error in the X-ray determination of Avogadro's number. M. Straumanis. *Z. Phys.*, **126** (*Nos* 1–2) 65–6 (1949) *In German.*

Since calcspar is a mixed crystal with a mean molecular weight of 100·095 the value of N obtained by X-ray methods is $6{\cdot}0245_7 \times 10^{23}$, instead of the formerly accepted value of $6{\cdot}0243_1 \times 10^{23}$. e is then $1{\cdot}602_1 \times 10^{-19}$ A . sec. These data refer to work done in 1944. More recent calculations give N the value $6{\cdot}0238_5 \times 10^{23}$ on the chemical scale. A. J. Mee

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

1144. A possible standard for radioiodine. A. H. W. Aten, Jr. *Science*, **110**, 394–5 (*Oct.* 14, 1949).

The absorption in Al of β-rays from Cl^{36} is shown to be almost identical to that from I^{131} if a filter 0·125 g/cm^2 is placed over the Cl^{36}. The Cl provides a preferable standard to the Tl isotope prev. used for calibration of I^{131} samples [*ibid.*, **109**, 456 (1949)]. F. T. Farmer

539.16.08

1145. The standardisation of Co^{60}. W. B. Mann. *Nat. Res. Coun. Can. Publ.* (*No.* 1909) 3 *pp.* (1948).

Co^{60} was available in 0·1 N HCl solution, from which measured quantities were evaporated on Al

planchettes. These sources were studied with a single β counter and 2 γ counters, set up in a Pb castle, and the activities determined by the coincidence technique. Spurious effects were minimized by the geometry adopted and appropriate corrections were made. Resulting estimates of the solution activity were in good agreement with those obtained elsewhere on samples taken from the same solution.

L. R. SHEPHERD

539.16.08

1146. The standardization of I^{131}. R. C. HAWKINGS, R. F. HUNTER AND W. B. MANN. *Nat. Res. Coun. Can. Publ.* (*No.* 1910) 5 *pp.* (1948).

I^{131} was precipitated from soln. as cuprous iodide. The active sample was studied by the coincidence technique using the equipment previously employed in the Co^{60} standardization [see preceding Abstr.] The coincidences were observed between 600 keV β-particles and 370 and 80 keV γ-rays, with a γ counter whose efficiency was known as a function of energy. Interpretation of the results is subject to uncertainties arising from lack of data on the decay scheme of I^{131}. Backscattering corrections are discussed.

L. R. SHEPHERD

539.16.08

1147. Nuclear instrument handbook—measurement problems and properties of materials. H. L. ANDREWS, D. BALBER, S. C. BROWN AND L. YAFFE. *Nucleonics*, **4**, 106–41 (*May*, 1949).

The handbook is designed as a guide to the use of radioactive materials in research, for people with very little previous knowledge of the subject. Brief descriptions of possible detectors for the different types of radiation are first given. The problems of radiobiological work are then discussed, and some details are given of special types of detector for β- and γ-rays. A section on radiochemistry deals in an elementary way with absolute intensity measurements of α-, β- and γ-rays and neutrons. The subject of "Health Physics" is treated in tabular form, with details of allowed dosage rates for different radiations, and lists of appropriate detecting apparatus for various ranges of intensity. The methods of monitoring personnel, air, water and sewage, and laboratory furnishings are given separately. The possible uses of radioactive isotopes in industrial research are discussed in a very qualitative way. Special sections, with a fair amount of detail, are devoted to (*a*) the properties and uses of nuclear photographic emulsions, and (*b*) the gases that are of value as Geiger counter fillings. A. P. FRENCH

539.16.08

1148. Use of Geiger counter for quantitative estimation of phosphorus 32 in histological sections. H. F. ATKINSON. Letter in *Nature, Lond.*, **164**, 541 (*Sept.* 24, 1949).

Measurement of radioactivity in minute areas of enamel of teeth simultaneously with microscopic examination. F. T. FARMER

539.16.08

1149. Safety criteria in water monitoring. H. A. C. MCKAY AND G. N. WALTON. *Nucleonics*, **5**, 12–21 (*Aug.*, 1949).

The safety condition is expressed algebraically as an inequality, usually involving the total counting rate from a sample. It takes various forms, corresponding to decreasing stringency as the amount of detailed information about the sample is increased. Actual monitoring procedures, in which α-, β-, and $(\beta + \gamma)$-activities can be measured, are described, and the use of the safety criteria is illustrated with numerical examples. A. P. FRENCH

539.16.08

1150. Instrumentation for a nuclear reactor. D. COCHRAN AND C. A. HANSEN, JR. *Nucleonics*, **5**, 4–11 (*Aug.*, 1949).

An outline description is given of a reactor designed for electric power production, running at high temp. with liquid metal coolant. The instrumentation problem is subdivided under the headings: Plant Operation, Plant Maintenance and Health; only the 1st two are considered. The types of quantity to be measured, with what accuracy and over what range, are tabulated, and the methods of measurement are discussed in a general way. A. P. FRENCH

539.16.08

1151. On the measurement of radioactivity from paper chromatogram. O. LINDBERG AND J. P. HUMMEL. *Ark. Kemi*, **1**, *Paper* 2, 17–19 (1949) *In English.*

Strips of filter paper 50 cm long are moistened at a marked point with 0·01 cm^3 of solution to be investigated. After about 12 hr the paper is dried and passed under a G.M. tube and the counting rate recorded. Some biochemical examples are given.

F. T. FARMER

539.16.08 : 537.542

1152. Bibliography on radiation detection. H. H. GOLDSMITH. *Nucleonics*, **4**, 142–50 (*May*, 1949).

A selection of the more important papers in the following fields: Geiger counters; proportional counters; ionization chambers; crystal counters; scintillation counters; electron multipliers; photographic plates. [See also Abstr. 4833, 4834 (1949)].

A. P. FRENCH

539.16.08 : 778.3

1153. The detection of Ca^{45}, I^{131}, P^{32}, and Zn^{65} by photographic film. D. STEINBERG AND A. K. SOLOMON. *Rev. Sci. Instrum.*, **20**, 655–9 (*Sept.*, 1949).

The density response of photographic emulsions to the radiations of Ca^{45}, I^{131}, P^{32} and Zn^{65} has been determined. Characteristic curves for all 4 isotopes against Eastman no-screen X-ray film and Eastman type *M* stripping film are presented, together with certain additional studies on Eastman *NTB* stripping film and Eastman type *K* X-ray film. The relative photographic effectiveness of the isotopes examined increases in the order: Zn^{65}, P^{32}, I^{131}, Ca^{45}, C^{14}. Applications of the data for quantitative radioautography are discussed. [See also Abstr. 3905 (1948)]. A.

539.163

1154. Radioactivity in holmium 166, thulium 170 and lutecium 177. J. M. CORK, H. B. KELLER AND A. E. STODDARD. Letter in *Phys. Rev.*, **76**, 986–7 (*Oct.* 1, 1949).

Pure specimens of Ho, Tm and Lu were irradiated by pile neutrons and the conversion electron spectra of the active samples recorded photographically.

The conversion lines observed were attributed to an 81·0 keV transition following the Ho^{166} decay, an 84·3 keV transition following the Tm^{170} decay and 113·1 keV and 208·6 keV transitions accompanying the Lu^{177} disintegration. The observed ½-lives were 27·7 h, 120 d and 6·7 d and the β-spectrum end points (determined by Al absorption) 1·64 MeV, 0·9 MeV and 0·46 MeV, corresponding respectively to the activities Ho^{166}, Tm^{170} and Lu^{177}. Pb absorption indicated a γ-ray of energy 0·92 MeV from the Ho^{166} activity. L. R. SHEPHERD

539.163.1

1155. The half-life of rubidium 87. M. KEMMERICH. *Z. Phys.*, **126** (*No.* 5) 399–409 (1949) *In German.*

The counting-rate of a G–M counter was investigated as a function of thickness (0·03–4 mg/cm²) of evaporated RbCl layers covering the inner cylindrical surface. Allowing for the int. conv. electrons [Abstr. 2674 (1949)] the ½-life of Rb^{87} was found to be $(6·0 \pm 0·6) \times 10^{10}$ yr. A. O. STANESBY

539.163.1

1156. A determination of the half-life of carbon 14. W. M. JONES. *Phys. Rev.*, **76**, 885–9 (*Oct.* 1, 1949).

Experiments are described involving the counting of an analysed and diluted sample of CO_2 containing C^{14} in a Geiger counter of known effective volume. The value of the ½-life is found to be 5 589 ± 75 yr. A.

539.163.1

1157. Experiments on the effect of atomic electrons on the decay constant of Be^7. II. R. F. LEININGER, E. SEGRÈ AND C. WIEGAND. *Phys. Rev.*, **76**, 897–8 (*Oct.*, 1949).

A comparison of the decay constants of Be^7 in beryllium oxide and in beryllium fluoride has given $\lambda(BeO) - \lambda(BeF_2) = (+ 1·375 \pm 0·053)10^{-3}\lambda(BeO)$ thus showing a definite effect of the chemical binding on the radioactive decay constant. A.

539.163.1

1158. The decay probability of Be^7 as a function of the ionization of the atom. P. BENOIST, R. BOUCHEZ, P. DAUDEL, R. DAUDEL AND A. ROGOZINSKI. Letter in *Phys. Rev.*, **76**, 1000–1 (*Oct.* 1, 1949).

539.163.1

1159. On the theoretical calculation of the variation of the period of Be^7 as a function of the ionization of the atom. P. BENOIST. *C.R. Acad. Sci., Paris*, **228**, 309–10 (*Jan.* 24, 1949) *In French.*

A revised calculation using self-consistent wave-functions gives a 2·7% increase in the period in going from Be to Be^{+++} which is > that using wave-functions based on an effective charge, owing to a better correction for the *L*-electrons. G. J. KYNCH

539.163.1 : 539.164

1160. Life-time for pair emission by spherically symmetrical excited state of the O^{16} nucleus. S. DEVONS, H. G. HEREWARD AND G. R. LINDSEY. Letter in *Nature, Lond.*, **164**, 586–7 (*Oct.* 1, 1949).

Initial measurements with a pulsed proton beam indicated that pair emission by O^{16} followed the $F^{19}(p, \alpha)$ reaction in a time $\ll 10^{-6}$ sec. Further experiments were carried out using a suitable arrangement of apertures, to determine the average point along the track of the recoiling O^{16} nucleus at which pair emission occurred. It was estimated that the mean distance travelled by the O^{16} nuclei before the emission was 0·18 mm corresponding to a mean life of 7×10^{-11} sec for the excited state. Assuming the excited nucleus to be a uniformly charged sphere with uniform dilation, the observed life-time can be used to calculate the nuclear compressibility and a value is obtained in good agreement with that obtained from other nuclear data. A model of O^{16} consisting of 4 α-particles at the vertices of a regular tetrahedron leads to a mean life-time many orders of magnitude > that observed. L. R. SHEPHERD

539.164

1161. Alpha-particle detection with dental X-ray film. C. C. SMITH. *Nucleonics*, **5**, 72–3 (*Sept.*, 1949).

The α-particles are detected through the light-tight cover of the dental films, as a result of β-activity induced by the α-particles in this covering material. The β-particles are able to penetrate the wrapper and reach the emulsion. L. R. SHEPHERD

539.164

1162. A new determination of the fine structure of the radium α-particle spectrum. S. ROSENBLUM, M. GUILLOT AND G. BASTIN-SCOFFIER. *C.R. Acad. Sci., Paris*, **229**, 191–3 (*July* 18, 1949) *In French.*

Using a permanent-magnet α-particle spectrograph with a very weak source (~4 microcurie) and long exposure (1–5 d) the ratio of intensities of the 2 groups at 4·795 MeV (α_0) and 4·6105 MeV (α_1) was found to be $\alpha_1/\alpha_0 = 6·9\%$, compared with the value 1·8% of Chang [Abstr. 964 (1947)]. A weak group was indicated at ~600 keV, of intensity ~2% of α_1; it is being investigated. A. O. STANESBY

539.164

1163. Some upper limits of possible alpha-activity. K. JENKNER AND E. BRODA. *Nature, Lond.*, **164**, 412–13 (*Sept.* 3, 1949).

Nuclear emulsions were examined for α-particle tracks at periods varying up to 7 months after impregnation with various ions, and the following min. ½-lives (in 10^{15} yr) deduced from the absence of tracks other than those due to contamination by known radioactive isotopes: Rb : 17; Mo : 9; Cd : 6; Pb, Bi : 3; Zr : 2. Also, for comparison, Sm : 10^{12} yr; Th : $1·4 \times 10^{10}$ yr, and for Ag, Br, in unimpregnated emulsions, > 10^{18} yr. A. O. STANESBY

539.164

1164. Determination of the α-energy of U^{235} and the half-life of U^{234}. E. BALDINGER AND P. HUBER. *Helv. Phys. Acta*, **22** (*No.* 4) 365–8 (1949) *In German.*

A thin U layer was electrolytically deposited on one plate of a parallel-plate N-filled chamber with ion collection (5 atm. pressure, 9 kV/cm field). After amplification, the pulses were taken to (*a*) a 19-channel pulse analyser, by which the relative numbers of α-particles from U^{234}, U^{235} and U^{238} could be accurately found, and (*b*) a c.r.t. spectrograph, by which the positions of the 3 peaks could be determined. The ½-lives of U^{234} and U^{235} were found to be $(2·33 \pm 0·1) \cdot 10^5$ yr and $(8 \pm 1·5) \cdot 10^8$ yr respectively, assuming $4·51 \cdot 10^9$ yr for U^{238}. The energy of the U^{235} α-particles was found to be 4·393 ± 0·01 MeV taking the other 2 energies as known. Agreement with other values [Abstr. 2054 (1949)] is good. A. P. FRENCH

539.164

1165. Study of the electronic radiation from ionium by the photographic plate method. G. Albouy, H. Faraggi, M. Riou and J. Teillac. *C.R. Acad. Sci., Paris*, **229**, 435–6 (*Aug.* 17, 1949) *In French.*

Ilford Nuclear Research plates, type G5 (200 μ emulsion) were impregnated with Io + Th nitrate in 5% acetic acid soln., dried, and examined for α-particle and electron tracks after 4 days. The mean range of the Io α-particles in the emulsion was 18·81 μ (stopping power 1 660); of the associated mono-energetic electrons ($\sim$ 48 keV, 10 $\pm$ 1 electrons per 100 disintegration) $\sim$ 12·5 μ (stopping power $\sim$ 3 200). There is still a discrepancy in intensity for the excited state at 68 keV. [See Abstr. 4954, 4955, 4960 (1949)]. A. O. STANESBY

539.164 : 539.155.2

1166. Binding energies of alpha-particles in medium-heavy nuclides. T. P. Kohman. Letter in *Phys. Rev.*, **76**, 448–9 (*Aug.* 1, 1949).

A curve is shown of the α-binding energy as a unction of mass number, obtained from values of packing fractions up to $A = 206$, and from α-disintegration data for higher masses. It is suggested that the very light isotopes of certain medium-heavy elements may be α-active. B. ROSE

539.164 : 539.166 : 535.371

Luminescent output of zinc sulphide excited by α- and γ-rays. *See Abstr.* 883

539.165

1167. On the possibility of a mode of disintegration by *K*-capture of the nuclide $_{79}Au^{198}$. G. A. Renard. *C.R. Acad. Sci., Paris*, **228**, 310–12 (*Jan.* 24, 1949) *In French.*

A continuation of previous work [Abstr. 3921 (1949)]. Using a proportional counter at high amplification, a line at $\sim$ 80 keV was observed in the decay of Au^{198}. The accuracy was insufficient to show definitely the presence of Pt *K* radiation, which should result from *K*-capture. B. ROSE

539.165

1168. *K*-capture and positron emission in Cu^{61} and Cu^{64}. O. Huber, R. Rüetschi and P. Scherrer. *Helv. Phys. Acta*, **22** (*No.* 4) 375–8 (1949) *In German.*

The ratios λ of *K*-capture to positron emission were found for Cu^{61} and Cu^{64} separately, as an earlier measurement [Abstr. 827 (1946)] of $\lambda^{61}/\lambda^{64}$ had shown marked disagreement with the Fermi theory for allowed transitions. The new determination required absolute intensity measurements of the Ni *K*-radiation and of annihilation quanta. For the former a double-counter arrangement was used (a known fraction of the quanta passing through the 1st counter being allowed to enter the 2nd, and the counters being assumed of equal efficiency); for the latter a counter was screened so as to receive quanta over only a small part of its central region, and the constant efficiency over this region was determined by normal coincidence methods. The results gave $\lambda^{64} = 1{\cdot}75 \pm 0{\cdot}2$, $\lambda^{61} = 0{\cdot}32 \pm 0{\cdot}03$; these are $\sim$ 15% lower and higher, respectively, than the theoretical values. A. P. FRENCH

539.165

1169. Apparent straggling of $_{16}S^{35}$ beta-particles in glass. M. J. A. Linker and F. T. Rogers, Jr. Letter in *Phys. Rev.*, **76**, 428 (*Aug.* 1, 1949).

The transmission, through glass, of β-particles in the energy range 35–62·5 keV was studied by examining the S^{35} β spectrum with an electrostatic analyser and a glass G.M. counter of 0·001 cm window thickness. The observed spectrum was compared with that computed from Fermi's theory, thereby giving the transmission coeff. of the window as a function of energy. Results have been analysed on the basis of an assumed Gaussian form for the stragging of β-particle ranges and a value of $4{\cdot}4 \times 10^{-4}$ cm (absolute deviation $0{\cdot}6 \times 10^{-4}$ cm) assigned to the straggling coeff. L. R. SHEPHERD

539.165

1170. Absolute beta counting. B. P. Burtt. *Nucleonics*, **5**, 28–43 (*Aug.*, 1949).

A detailed account is given of expts. by which the corrected efficiency E for an end-window counter could be deduced. E is defined as the ratio of counting rate to disintegration rate for a hypothetical weightless source in which there is no back-scattering and no absorption between the source and the sensitive volume of the counter. It is not in general equal to the calculated geometrical efficiency. Measurements were made on thin sources with different backings; the factor by which the counting rate was increased by the backing was shown to be almost independent of (*a*) source-counter dist., provided this was $> 0{\cdot}5$ cm, and (*b*) β-energy, if $> 0{\cdot}6$ MeV. The effect of transverse and longitudinal displacement of the source with respect to the counter axis was studied; the latter changes the counting rate more rapidly than the inverse square law would suggest. No appreciable scattering into the counter from the structure carrying counter and source could be detected. It is shown that to get an absorption curve suitable for extrapolation back to zero absorber thickness, the absorbers must be placed near the counter, not near the source. Absolute efficiencies were found by using thin Ra $E + F$ sources for which the β-counting rate could be inferred from an absolute measure of the α-counts. It is considered that the best possible determination of an absolute β-disintegration rate has an error $> \pm 2\%$.

A. P. FRENCH

539.165

1171. The role of bound electrons in radioactive phenomena. R. Daudel and M. Jean. *C.R. Acad. Sci., Paris*, **229**, 354–6 (*Aug.* 1, 1949) *In French.*

A discussion of the various probabilities on the excitation and ionization of atoms after β-disintegration. G. J. KYNCH

539.165

1172. The beta-spectrum of Tl^{204}, magic numbers and neutron pairing. D. Saxon and J. Richards. Letter in *Phys. Rev.*, **76**, 982–3 (*Oct.* 1, 1939).

A Tl^{204} source, prepared by pile irradiation of Tl nitrate and allowed to decay for 2 yr to eliminate shorter period activities, was examined in 180° spectrometer with 2% resolution. A forbidden Kurie plot, assuming $\Delta I = 2$ and parity change gave

a straight line from the β-spectrum end-point (783 ± 10 keV) down to ~350 keV where a large deviation occurred. The existence of a low energy β-component or sufficient residual scattering to explain the observed deviation, is ruled out and it is considered possible that the transition may be 2nd forbidden with $\Delta I \geqslant 2$. A spin change of two or more, in this transition, supports conjecture on the pairing of higher angular momentum neutrons in heavy elements. L. R. SHEPHERD

539.165

1173. Investigation of soft radiations by proportional counters. VI. The beta spectrum of sulphur 35. A. L. COCKROFT AND G. M. INSCH. *Phil. Mag.*, **40**, 1014–18 (*Oct.*, 1949).

The spectrum was analysed by using a large counter [Abstr. 5626 (1949)]. The spectrum has a max. intensity at ~16·5 keV and shows departure from the Fermi distribution for an allowed transition in the region of low energies. L. S. GODDARD

539.165

1174. A new method of analysis of the beta-ray spectrum. M. SAKAI AND S. NAKAMURA. *Phys. Rev.*, **76**, 967–9 (*Oct.* 1, 1949).

A new method of analysis is developed for taking into account the β-ray spectrum as a whole. Stress is laid on the point of max. intensity of the spectrum, rather than the lower or the upper end. Tentative conclusions drawn by this method are as follows: (1) Experimental spectra now available show some deviations from Fermi theory which should be considered as a standard reference. (2) These deviations are found to manifest a certain tendency without any distinction between the allowed and the forbidden transitions. (3) These deviations tend to increase with the atomic number of the elements and are hardly related to the upper end of the spectrum. Hence, the forbidden correction factors are not likely to explain these deviations. A possible elucidation is discussed which is due to the Coulomb effect. A.

539.165

1175. [Beta-particle] energy spectrum of tantalum^{182}. S. JNANANANDA. *J. Sci. Industr. Res.*, **8B**, 147–50 (*Sept.*, 1949).

Determined using magnetic lens spectrometer with counter recording. The transition, $Ta^{182} \xrightarrow{\beta,\gamma} W^{182}$, is allowed, with at least 3 components; for the hardest, $E_{max} = 525 \cdot 3$ keV. A. O. STANESBY

539.165

1176. The beta spectrum of tritium. S. C. CURRAN, J. ANGUS AND A. L. COCKROFT. Letter in *Phys. Rev.*, **76**, 853–4 (*Sept.* 15, 1949).

As a continuation of previous work [Abstr. 3887 (1948)] the end-point has been further studied. If the end-point is taken as 18·0 keV, the neutrino mass is between 0 and 1 keV, whilst if the neutrino mass is zero, the end-point is between 18·0 and 18·6 keV, in agreement with other work [Abstr. 6397 (1949)]. B. ROSE

539.165

1177. The beta-ray spectrum of chlorine^{36}. C. S. WU AND L. FELDMAN. Letter in *Phys. Rev.*, **76**, 693–5 (*Sept.* 1, 1949).

Thin sources of LiCl (300 μg–1 mg/cm^2) containing Cl^{36} were examined in a high transmission (6–7%) solenoid type β-spectrometer, using the ring focus principle to obtain good resolution (4%). A marked departure from the allowed shape of spectrum was revealed by the conventional Fermi plot, which gave a curve concave towards the energy axis. The D_2 correction factor given by Marshak for the forbidden decay of Be^{10} ($\Delta J = \pm 3$), was found to correct the Cl^{36} Fermi plot to a straight line (end-point 713 keV). This result is not expected, however, since observations on the $Cl^{36}CN$ microwave absorption spectrum indicate a spin 2 for Cl^{36}, while the even–even A^{36} almost certainly has spin zero. L. R. SHEPHERD

539.165

1178. On the spin and beta-spectrum of Cl^{36}. C. LONGMIRE, C. S. WU AND C. H. TOWNES. Letter in *Phys. Rev.*, **76**, 695–6 (*Sept.* 1, 1949).

The observed shape of the Cl^{36} β-spectrum cannot be explained for a $2 \rightarrow 0$ transition with any single type of interaction and the appropriate parity change. An attempt is made to fit the distribution by assuming combinations of two interactions. Satisfactory results are obtained with 2nd forbidden scalar-tensor and axial vector-polar vector combinations. These mixed interactions also satisfy the Y^{91}, Y^{90}, Sr^{90}, Sr^{89} and Cs^{137} β-spectra. L. R. SHEPHERD

539.165

1179. Beta-spectrum of Y^{91}. C. S. WU AND L. FELDMAN. Letter in *Phys. Rev.*, **76**, 696–7 (*Sept.* 1, 1949).

A marked difference was observed between the shapes of the β-spectra of Y^{91} and Cl^{36} examined in the solenoid spectrometer. The Y^{91} spectrum agrees well with the theoretical form for a 1st forbidden, $\Delta J = \pm 2$ transition, but that of Cl^{36} does not correspond to this type of transition. The forbidden Fermi plot ($\Delta J = \pm 2$, yes) is found to be straight down to 200 keV, in the case of Y^{91}, with an end-point at 1·55 ± 0·01 MeV. L. R. SHEPHERD

539.165

1180. Interpretation of beta-spectra from thick sources. L. FELDMAN AND C. S. WU. Letter in *Phys. Rev.*, **76**, 697–8 (*Sept.* 1, 1949).

Y^{91}, P^{32} and RaE were diluted with inert KaCl to give thick sources ~20 mg/cm^2 and the observed spectra compared with those for very thin sources. P^{32}, which gives a straight line in the allowed Fermi plot, when a thin source is employed, was found to give a line convex towards the energy axis with the thick source; Y^{91}, concave towards the energy axis, above 600 keV, gave an almost straight Fermi plot when the thick source was used; RaE, which is convex towards the energy axis in the conventional Fermi plot, appeared even more convex with the thick source. On the basis of these observations, results given previously by Alburger on the β-spectrum of an 18·5 mg/cm^2 K^{40} source, which yielded a straight Fermi plot above 450 keV, are assumed to indicate a true plot concave towards the energy axis. L. R. SHEPHERD

539.165

1181. The beta-spectrum of Be^{10}. C. S. WU AND L. FELDMAN. Letter in *Phys. Rev.*, **76**, 698–9 (*Sept.* 1, 1949).

A thick source (~10 mg/cm^2 of BeO) was needed

for a spectrometer study, owing to the very low specific activity of the Be^{10}. The apparent shape of the spectrum was that of a 1st forbidden, $\Delta J = \pm 2$ transition and not that predicted by Marshak for the Be^{10} transition ($\Delta J = \pm 3$). However, Cl^{36}, which exhibits the Marshak form when used in very thin sources, also appeared to follow the 1st forbidden $\Delta J = \pm 2$ shape, when mixed with BeO to give source thickness ~ 10 mgm/cm^2. It is possible, therefore, that the Be^{10} spectrum does conform to Marshak's predictions. L. R. SHEPHERD

539.165

1182. Decay of palladium-109. K. Siegbahn, E. Kondaiah and S. Johansson. Letter in *Nature, Lond.*, **164**, 405–6 (*Sept.* 3, 1949).

A 14·6 mgm/cm^2 Pd sheet was used as a spectrometer source. The electron spectrum consists of a simple β distribution of end-point 0·95 MeV and K and L conversion lines of a γ-ray of 87 keV. The internal conversion coeff. is estimated as probably >92% with $N_K/N_{L+M} = 1·3$. The 87 keV level of Ag^{109} is also excited in the decay of Cd^{109} by K capture and is known to have 40 sec ½-life. All data indicates an electric multipole order between $l = 3$ and $l = 4$ for the de-excitation of this level. L. R. SHEPHERD

539.165

1183. The disintegration of Ce^{141}. M. Ter-Pogossian, C. S. Cook, C. H. Goddard and J. E. Robinson. *Phys. Rev.*, **76**, 909–13 (*Oct.* 1, 1949).

The β- and γ-rays from 28 day Ce^{141} have been studied in a β-ray spectrometer. The max. β-particle energy is 560 keV and γ-rays at 146 keV and 315 keV have been found. With the additional aid of β-γ- and γ-γ-coincidence studies a disintegration scheme is proposed. The max. β-energy of Pr^{143} has also been determined as 920 keV. A.

539.165

1184. Angular correlation of delayed radiations. A. Lundby. Letter in *Phys. Rev.*, **76**, 993–4 (*Oct.* 1, 1949).

β^- decay of Hf^{181} occurs to a 20 μsec metastable level in Ta^{181} of energy 0·130 MeV. A study of the angular correlation between the β^- and conversion electrons, from a Hf^{181} source, was made with two G.M. counters, measurements being carried out on delayed coincidence rates with angular separations of 90° and 180° between the counters. A 2 μsec delay was introduced into one channel, the sum of the pulse lengths in the two channels being 1·9 μsec. The delayed coincidence rates were found to be substantially the same in both positions, deviation from isotropy, if any, being <15%. It is possible that any initial anisotropy may have had time to disappear in the 2–4 μsec which elapses between the observed emissions and further experiments are planned in which variable delays will be employed. L. R. SHEPHERD

539.165/.166

1185. Absence of angular correlation between β- and γ-rays in allowed β-transitions. M. A. Grace, R. A. Allen and H. Halban. Letter in *Nature, Lond.*, **164**, 538–9 (*Sept.* 24, 1949).

The β-γ-coincidence rates of Na^{24} and Co^{60} sources was studied as a function of the angle, subtended at the source, between the β and γ counters. Naphthalene scintillation counters were used for both purposes, the β counter crystal being made thin enough to ensure low γ counting efficiency. The ratio of the coincidence rate at separation π to that at $\pi/2$ was 0·99 ± 0·019 for Na^{24} and 1·00 ± 0·025 for Co^{60}. L. R. SHEPHERD

539.165/.166

1186. Study of the β spectrum and γ radiation of As^{76}. N. Marty, J. Labeyrigue and H. Langevin. *C.R. Acad. Sci., Paris*, **228**, 1722–4 (*May* 30, 1949) *In French.*

The energies of the two strongest lines of the spectrum were measured and found to be: (i) 567 ± 10 keV by Compton effect, 566 ± 4 keV by photoelectric effect using a U diffuser and 568 ± 4 keV with a Pb diffuser; and (ii) 1·250 ± 0·005 MeV by photoelectric effect. The intensity of the source would not allow detection of weaker lines. The β^- spectrum has an energy max. at 11 850 Hρ (3·08 MeV), and has been analysed into 4 spectra with energy max. at 3·15, 2·56, 1·5, 0·4 MeV and relative intensities 54, 21, 19, 7%. If β^+ exist in the spectrum, their number is < 0·5% of the number of β^-. R. B. SHEPHERD

539.165/.166

1187. Coincidence experiments in Ni^{65}, Ni^{57}, Ag^{110} and In^{114}. F. Maienschein and J. L. Meem, Jr. *Phys. Rev.*, **76**, 899–903 (*Oct.* 1, 1949).

Absorption in Al of the β-radiation from Ni^{57} gave a max. β-energy of 1·97 MeV. β-γ-coincidence absorption indicated another β-ray group at 0·46 MeV. γ-γ-coincidences were obtained, and coincidence absorption of the Compton-recoil electrons gave γ-rays of 1·64 and 0·3 MeV. The max. energy of the positrons from Ni^{57} was found to be 0·72 MeV by absorption in Al. β-γ-coincidences indicated the presence of only a single β-ray group. γ-γ-coincidences were obtained, and the energy of the most energetic γ-ray was found to be 1·97 MeV. The β-spectrum of Ag^{110} was shown to consist of β-ray groups of 0·09, 0·55 MeV and a very high-energy component of low intensity. β-γ-coincidences showed that the most energetic group leads to the ground state. A large γ-γ-coincidence rate was obtained, and the most energetic γ-ray was found to have an energy of 1·48 ± 0·1 MeV. In^{114} was found to emit a 0·196 MeV γ-ray and a 2·05 MeV β-ray as has been shown previously. In addition, γ-rays of about 0·5, 0·7 and 1·3 MeV were found. γ-γ-coincidences showed that 2 of these are in cascade and β-γ-coincidence absorption showed that they are not in coincidence with the 2·05 MeV β-ray. A.

539.166

1188. On the fluorescent *L*-radiation and the γ-radiation of ionium. M. Riou. *C.R. Acad. Sci., Paris*, **228**, 678–80 (*Feb.* 21, 1949) *In French.*

Detecting the radiation with Xe-alcohol-filled G.M. counters, and using the method of critical absorption, the photon energies were found to be ~14, 68 and 200 keV. The relative intensities were 9 ± 2, 0·50 ± 0·15 and 0·3 ± 0·1 respectively per 100 disintegrations. B. ROSE

539.166

1189. Radiations from Hf^{181}. E. N. JENSEN. *Phys. Rev.*, **76**, 958–61 (*Oct.* 1, 1949).

The radiations from Hf^{181} have been examined with a magnetic lens spectrometer. 4 γ-rays were found having energies of 0·087, 0·134, 0·347 and 0·485 MeV. There is evidence for the existence of a fifth γ-ray. The max. energy of the β-rays was estimated to be 0·41 MeV. The 3 higher energy γ-rays were found to have intensities proportional to 11, 29 and 100, respectively. The total internal conversion coeff. for the 0·134 MeV transition was calculated to be 11. Calculations on the life-time and the ratio of the conversion electrons in the K and L shells indicate that in the transition from the metastable state the nucleus undergoes a spin change of 3 units. A.

539.166

1190. Angular distribution of $\gamma\gamma$-coincidences in In^{111}. F. BOEHM AND M. WALTER. *Helv. Phys. Acta*, **22** (*No.* 4) 378–80 (1949) *In German.*

The angular correlation function for cascade γ-rays from Cd^{111} resulting from K-capture in In^{111} has been found to have the form $1 + A\cos^2\theta$ with $A = -0{\cdot}07 \pm 0{\cdot}04$. Taking the 173 keV and 247 keV γ-rays to be magnetic dipole and electric quadrupole respectively (inferred from internal conversion coeffs.) the excited levels could have spins 5/2 and 3/2 ($\rightarrow A = -0{\cdot}07$) or 7/2 and 5/2 ($\rightarrow A = -0{\cdot}10$), taking the ground-state spin as $\frac{1}{2}$.

A. P. FRENCH

539.166

1191. U-235 gamma-radiation. R. L. MACKLIN. *Phys. Rev.*, **76**, 596–7 (*Sept.* 1, 1949).

Evidence for the existence of a γ-ray accompanying the α-decay of U^{235} is presented. The energy of the γ-ray, as determined by several independent absorption measurements, is 162 keV. A.

539.166

1192. Gamma-ray measurements with a magnetic lens spectrometer. W. F. HORNYAK, T. LAURITSEN AND V. K. RASMUSSEN. *Phys. Rev.*, **76**, 731–9 (*Sept.* 15 1949).

Effects of instrument resolution and convertor thickness on photoelectron lines have been investigated experimentally for γ-radiation from 0·4 to 3 MeV. While determinations based on the high energy extrapolated edge of the lines seem to require no corrections for convertor thicknesses, the peak value, which does require corrections, is in some cases more easily located. Peak shifts determined for Th convertors near 0·5 MeV are extrapolated to other energies by use of theoretical arguments. Values based on both types of determinations are quoted for γ-radiation from the reactions $Li^7(p\,p')Li^{7*}$, $Be^9(d\,n)B^{10*}$ and $Co^{60}(\beta^-)Ni^{60*}$. The corresponding excited level transition energies obtained are Li^{7*}: 476·7 ± 0·9 keV; B^{10*}: 713·8 ± 1·3 keV; Ni^{60*}: 1172·4 ± 1·8 keV and 1 330·9 ± 2·1 keV. A.

539.166

1193. The X and γ rays emitted from $_{45}Rh^{104}$. B. N. CACCIAPUOTI. *R.C. Ist. Super. Sanità*, **10** (*No.* 4) 535–45 (1947) *In Italian.*

A report is given on the results of some measurements, performed with Xe filled counters, on the electromagnetic radiation emitted by $_{45}Rh^{104}$ with 44 sec $\frac{1}{2}$ period obtained from Rh by slow neutron bombardment. The absorption curves of such radiation, with Al, Ag and Pb absorbers and different geometrical arrangements, show that the X- and γ-rays emitted must be mainly ascribed to a "bremsstrahlung" effect of the disintegration electrons of $_{45}Rh^{104}$. A.

539.166

1194. Erratum: Bremsstrahlung in high energy nucleon-nucleon collisions. J. ASHKIN AND R. E. MARSHAK. Letter in *Phys. Rev.*, **76**, 989 (*Oct.* 1, 1949).

Previous paper [Abstr. 6415 (1949)]. Previously a set of intermediate states was omitted in the matrix-element of γ-emission in n–n and p–p collisions. With the approx. of neglecting nuclear recoil and the γ-ray momentum in certain terms, there should be no γ-emission. If the recoil is omitted the dipole moment of 2 protons is initially zero and remains zero so that there can be no dipole radiation. The classical argument is here justified by a classical treatment of the problem which gives the same results as the quantum treatment. G. J. KYNCH

539.166

1195. Pinhole camera for gamma-ray sources. D. E. COPELAND AND E. W. BENJAMIN. *Nucleonics*, **5**, 44–9 (*Aug.*, 1949).

The plate carrying the pinhole (~0·1 mm dia.) is mounted between 2 Pb blocks ~5 in thick, which have tapering holes so that the unobscured γ-ray paths are confined within a conic surface. The camera views a $\frac{3}{4}$ in field at 5 in from the pinhole. A photograph of a Ra needle at 4× magnification is shown to be much sharper than a contact print of the same. Exposure times are long, however (48–72 hr at 4× magnification). A. P. FRENCH

539.166

1196. On the theory of internal conversion. H. A. MEYER. *An. Acad. Brasil. Cienc.*, **22**, 101–10 (*June* 30, 1949) *In English.*

On the basis of Schönberg's quantum electrodynamics [Abstr. 1624 (1946), 860 (1949)], the values calculated differ from those obtained with the usual theory by only 6% at 0·8 MeV and 30% at 2·2 MeV for Ra-C. Experiments are hardly able to distinguish between the two sets. G. J. KYNCH

539.166 : 537.531

Mean square angles of bremsstrahlung, and pair production. *See Abstr.* 999

539.166.8

1197. Electron pair creation by a spherically symmetrical field. S. DEVONS AND G. R. LINDSEY. Letter in *Nature, Lond.*, **164**, 539–40 (*Sept.* 24, 1949).

The excited state of O^{16} (5·9 MeV) formed in the F^{19} (p, α) reaction decays to the ground state entirely by pair creation ($0 \rightarrow 0$ transition). The angular correlation of the emitted electron and positron has been calculated assuming even parity for the initial and final states and treating the O^{16} nucleus as a spherically symmetrical charge distribution, varying with time and having electromagnetic interaction with electrons in the negative energy states. The calculated angular distribution, averaged over all energies, has

been compared with experimental results obtained with coincidence counter arrays. Agreement between theory and experiment is fairly good though more pairs were observed with angular separation $>90°$ than the theory predicts. L. R. SHEPHERD

539.166.8

1198. Internal pair formation. M. E. ROSE. *Phys. Rev.*, **76**, 678–81 (*Sept.* 1, 1949).

The electron-positron angular correlation and total conversion coeff. are calculated for internal pair formation and for arbitrary multipole order of the electric and magnetic radiation fields. The Born approximation is used and in the region of greatest experimental interest, $Z \leqslant 40$ and γ-ray energy $>2{\cdot}5$ MeV, the consequent error should be negligible. Numerical results are given for multipole fields of order 2^l with $l = 1$ to 5 inclusive. A.

539.167

1199. A note on perturbation theory as applied to collision stimulated processes. J. N. SNYDER AND W. H. FURRY. *Phys. Rev.*, **76**, 359–62 (*Aug.* 1, 1949).

If a particle which can decay spontaneously is subjected to collisions with other particles the transition probability may be changed. The calculation of such an effect by the usual time-dependent perturbation methods is complicated by the circumstance that energy can be conserved in some intermediate states, because of the possibility of elastic scattering. The perturbation calculation is here modified in such a way that the resulting expression for the whole transition probability does not contain any divergences or spurious effects. By suitable approximations the expression is separated into two parts, one of which gives the probability of elastic scattering followed by a spontaneous transition, and the other the true stimulated transition probability which causes a change in the life-time. A.

539.167

1200. Applications of nuclear physics. K. STARKE AND G. SCHUBERT. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt. Germany*] "*Nuclear Physics and Cosmic Rays II*," 127–41 (1948) *In German.*

Some chemical properties of radioactive substances and some reactions associated with nuclear processes are discussed. The uses of radioactive materials in analytical and physical chemical studies are described. Investigations with active emanations are separately considered. Biological and medical applications are then described: the concentration of radioelements in various organs and tissues, and the study of vital processes using tracer elements (including a study of multiplication in tobacco mosaic virus). Some measurements with naturally radioactive indicator elements are also described. A. P. FRENCH

NUCLEAR REACTIONS 539.17

539.17 : 521.042

1201. Cosmic nuclear abundance and natural β-activity. H. E. SUESS. *Z. Phys.*, **125** (*Nos* 4–6) 386–93 (1948) *In German.*

Abnormal abundances associated with various mass-numbers are discussed. R. A. NEWING

539.17 : 521.042

1202. On the equation of state at high temperatures and densities. H. STEINWEDEL AND J. H. D. JENSEN. *Z. Phys.*, **125** (*Nos* 4–6) 394–404 (1948) *In German.*

The investigation is in relation to the Jensen–Suess theory of the abundance distribution of elements [Abstr. 2101 (1949)], which is found to require that the β-decay of neutrons does not keep pace with the initial changes in temperature and density.

R. A. NEWING

539.172

1203. Unclassified researches in nuclear physics at Chalk River—1948 W. B. LEWIS. *Nat. Res. Coun. Can. Publ.* (*No.* 1915) 11 *pp.* (1948).

Accurate spectroscopy of neutron capture γ-rays has been possible with the intense neutron beams available from the heavy water pile, which has a central flux of 3×10^{13} thermal neutrons/cm^2/sec and external beams $\sim 10^{-5}$ of this intensity. The energy of the γ-radiation emitted by the excited Li^7 nucleus formed in the reaction $B^{10}(n, \alpha)$ has been found to be $478{\cdot}5 \pm 1{\cdot}5$ keV. A Doppler spread in the energy of this radiation shows that it is emitted while the recoiling Li^7 nucleus is still in motion, indicating a $\frac{1}{2}$-life $< 3\times10^{-13}$ sec. A value of $2{\cdot}236 \pm 0{\cdot}005$ MeV has been obtained for the energy of the γ-rays from the $H(n, \gamma)D$ reaction indicating that the mass of the neutron is $1{\cdot}008992 \pm 0{\cdot}000010$ units ($O^{16} = 16{\cdot}0000$). Observations on the decay products of mesons in a graphite block have indicated the existence of a soft component assumed to be electrons and a hard component which probably consists of bremsstrahlung produced by the electrons. The energy end-points of β-spectra have been deduced from measurements on back-scattering from various materials, which has been shown to be a function of the max. β energy. A value of 167 ± 5 keV has been obtained for the S^{35} β end-point, using the back-scattering method. Other work has been carried out on the variation in the isotope ratios in natural B and S; the estimation of radiation doses in aqueous solutions from the reduction of ceric sulphate in dilute solution; the use of proportional counters for determining electron energy spectra and on the use of quartz fibres in electroscopes and microbalances. Experiments are projected to observe the β-decay of the neutron and to measure γ-ray spectra with a pair spectrometer. A 3–5 MeV van der Graaf generator is under construction. L. R. SHEPHERD

539.172

1204. Nuclear structure and nuclear processes [other than fission]. H. EWALD, A. FLAMMERSFELD, S. FLÜGGE, B. KARLIK, H. MAIER-LEIBNITZ AND W. RAMM. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt. Germany*] "*Nuclear Physics and Cosmic Rays I*," 107–69 (1948) *In German.*

The results of some calculations on eigenfrequencies of liquid drop nuclei are given; the rest of the review concerns primarily experimental topics. There is a discussion of recent mass determinations by mass spectrographic methods, with checks and extensions obtained from energy releases in various nuclear reactions. Results of the interpolation method for determining isotopic abundances [Abstr. 1624, 1627, 2909 (1948)] are given, and a table of the results, with

comparison of computed and observed chemical atomic weights, is appended. A few new results on natural α- and β-decay are given. The essential results of slowing down and diffusion theory for neutrons are summarized, and measurements of quantities appearing in the formulae (slowing-down lengths, scattering and capture cross-sections, etc.) are reported. Measurements of thermal neutron cross-sections obtained by observing (*a*) total absorption, (*b*) lowering of neutron density near an absorber, and (*c*) activation are listed. A section on nuclear processes and artificial radioactivity contains a variety of data on yields, cross-sections, excitation curves (α-, p- and d-induced reactions) and periods of activities. The results of a study of slow neutron (n, γ) reactions in the rare earths [Abstr. 1311 (1947)] are fully reported. The energies of excitation levels in a number of nuclei as found from energies and yields of emitted α-, β- or γ-rays or neutrons are given. Decay schemes are suggested for a few isotopes. There is finally a section on theoretical and experimental studies of nuclear isomerism.

A. P. FRENCH

539.172 : 550.367

1205. The neutrinos from the sun and the source of the earth's heat. D. SAXON. Letter in *Phys. Rev.*, **76**, 986 (*Oct.* 1, 1949).

The inverse β-reaction, $e^- + H \rightarrow n + \nu$, was studied with a van der Graaf generator, which was used to bombard paraffin with 1 MeV electrons. A B^{10}-lined, $B^{10}F_3$ filled proportional counter was employed to detect possible neutrons from the reaction. Failure to observe these led to the assignment of an upper limit of $2{\cdot}5 \times 10^{-37}$ cm^2 to the neutrino interaction cross-section. With this limit, it is shown that most of the neutrinos from the decay of N^{13} and O^{15} in the Bethe cycle must escape from the sun, giving a flux $\sim 3{\cdot}5 \times 10^{11}$/cm^2/sec at the earth. Absorption of solar neutrinos by the earth could not account for more than 4% of the observed heat.

L. R. SHEPHERD

539.172 : 778.3

1206. The determination of the charge of heavy particles emitted during the explosive disintegration of nuclei. S. O. C. SÖRENSEN. *Phil. Mag.*, **40**, 947–55 (*Sept.*, 1949).

The charge may be precisely determined if the length of the track in a photographic emulsion is of the order of 1 500 μ or greater. The method is based on the number of δ-rays per unit length which contain more than a certain number of grains. The maximum observed energies of ejection of light nuclei, Li, Be and B are of the order of 500 MeV.

L. S. GODDARD

539.172.1

1207. On the angular distribution of D–D reaction products. Y. NAKANO. Letter in *Phys. Rev.*, **76**, 981–2 (*Oct.* 1, 1949).

The angular distribution of these products is of the form $A(1 + B\cos^2\theta + C\cos^4\theta)$ in the range 1–3·5 MeV. The calculations of Konopinski and Teller [Abstr. 2577 (1948)] on A and B have now been extended to include C. The agreement between theory and experiment is then extremely satisfactory.

G. J. KYNCH

539.172.1

1208. On the activities in depth of silver irradiated by deuterons. C. CHAMIÉ, H. FARRAGI AND B. MARQUES. *C.R. Acad. Sci., Paris*, **229**, 358–60 (*Aug.* 1, 1949) *In French.*

Continuation of previous work [Abstr. 7258 (1949)]. Using the stacked foil technique, activities have been observed at various depths, produced by 6·5 MeV deuterons, and in particular that of 6·67 hr Cd^{107} at depths exceeding the range of the incident particles.

B. ROSE

539.172.1

1209. On the activity in silver irradiated by 6·5 MeV deuterons, at depths exceeding their range. C. CHAMIÉ, H. FARAGGI AND R. NATAF. *C.R. Acad. Sci., Paris*, **229**, 422–3 (*Aug.* 8, 1949) *In French.*

Continuation of previous abstr. The activity is ascribed to the reaction $Ag^{107}(p, n)Cd^{107}$, the distribution of the activity indicating resonances in the reaction. The protons are produced by $D(d, p)H^3$ due to D contamination of the target. Protons of range 300 mgm/cm^2 were observed in a photographic plate.

B. ROSE

539.172.1

1210. Proton groups from the bombardment of argon by deuterons. P. W. DAVISON, J. O. BUCHANAN AND E. POLLARD. *Phys. Rev.*, **76**, 890–1 (*Oct.* 1, 1949).

The d bombardment of A in both ordinary form and with a 26% concentration of A^{36} shows the presence of 13 groups of protons. Correct assignment to isotope can be made for 10 of these and probable assignment for the others. The Q-values for the reactions are: $A^{36}(d, p)A^{37}$ 6·59; 5·06; 4·92; 4·32; 4·03; 3·13 and 1·58 and $A^{40}(d, p)A^{41}$ 3·84; 3·18; 2·63; 2·50; 1·90; 1·57; 1·04; 0·55; 0·15; −0·17. The mass difference $A^{37} - A^{36}$ is 0·99951 and $A^{41} - A^{40}$ is 1·00247. Considering that the nuclei differ by 4 neutrons there is surprisingly little difference in general level structure. The first excited state of A^{37} is at an unusually high value.

A.

539.172.1 : 539.152.1

1211. Scattering by a nuclear potential. L. JÁNOSSY AND J. MCCONNELL. *Proc. Roy. Irish Acad. A*, **52**, 203–22 (*Sept.*, 1949).

To determine the range of validity of the Born approx. both the second-order correction and the radiation damping correction are calculated using the matrix elements of a Yukawa potential. The second-order Born approx. is generally small at all energies if $g^2(M/\mu) \ll 1$, although it is always small for large enough incident momentum. For a meson field, assuming $(M/\mu) = 10$ and $g^2 = 0{\cdot}05$ the first condition is hardly satisfied. The radiation damping correction is also relevant, and a detailed discussion shows that because of both corrections Born approx. is unsuitable for large angle scattering for energies below 10^9 eV. Electron scattering by a screened Coulomb potential around a proton can be calculated in this approx. below 500 eV for small angles and $5 \cdot 10^4$ eV for large angles. For an unscreened potential it is never applicable except for small-angle scattering.

G. J. KYNCH

539.172.1 : 539.152.1

1212. Three-body scattering with central and tensor forces. R. THOMAS. Letter in *Phys. Rev.*, **76**, 1002–3 (*Oct.* 1, 1949).

Born approx. has been used to calculate the angular distribution with potentials of the form $G_{12}(1 + S_{12})J(r)$ where G is an exchange operator of ordinary, Majorana, Heisenberg, charge symmetric or charge and spin symmetric types. S is the tensor spin operator. The cross-sections found are of the form $\sigma = C(\sigma_s + \sigma_t)$ where σ_s is due to the central force and σ_t to the tensor force. Gaussian functions are used both for the potential $J(r)$ and the deuteron wave function. G. J. KYNCH

539.172.1 : 539.155.2

1213. Energy levels in N^{15} and N^{16}. L. D. WYLY. Letter in *Phys. Rev.*, **76**, 316–17 (*July* 15, 1949).

Ordinary and enriched NH_3 was bombarded with deuterons, and from the observed proton groups, Q-values for $N^{14}(d, p)$ were determined in agreement with earlier work [Abstr. 2171 (1947)]. From proton groups ascribed to $N^{15}(d, p)$, the mass of N^{16} is found to be $16{\cdot}01121 \pm 0{\cdot}00023$. B. ROSE

539.172.1 : 539.185

1214. Neutrons from C(*d,n*)N and Cu(*d,n*)Zn. J. C. GROSSKREUTZ. *Phys. Rev.*, **76**, 482–6 (*Aug.* 15, 1949).

The energy distribution among the neutrons emitted from C and Cu bombarded by 10 MeV deuterons has been investigated by means of proton recoils in photographic emulsions. A description of the method is given. Two excited levels are observed in N^{13} at $2{\cdot}29 \pm 0{\cdot}12$ MeV and $3{\cdot}48 \pm 0{\cdot}12$ MeV, the latter not having been observed previously. Q for the production of N^{13} in the ground state is found to be $-0{\cdot}29 \pm 0{\cdot}09$ MeV. Both the reactions (d, n) and $(d, 2n)$ have been identified in the effects occurring when Cu is bombarded by 10 MeV deuterons. Quantitative agreement with the expected energy range of the neutrons from the $(d, 2n)$ reaction is found. There is also evidence for some type of level structure in Zn. Discussion is given of a possible interpretation of this structure. A.

539.172.11

1215. Excitation functions for (α,*n*), (α,2*n*) and (α,3*n*) reactions on indium. G. M. TEMMER. *Phys. Rev.*, **76**, 424–6 (*Aug.* 1, 1949).

37 MeV α-particles were used to bombard In. 3 products Sb^{116}, Sb^{117} and Sb^{118} were identified chemically and by calutron analysis to establish the occurrence of the reactions $(\alpha, 3n)$, $(\alpha, 2n)$ and (α, n) on In^{115}. The activities were resolved with a magnetic β-ray spectrometer; 2·8 hr Sb^{117} giving electrons due to the conversion of a 156 keV γ-ray; 5·1 hr Sb^{118}, a conversion peak due to a 260 keV transition and 60 min Sb^{116} emitting positrons with 1·45 MeV end point. Any one of these could be observed separately by an appropriate spectrometer setting and use of a helical baffle. The excitation functions were obtained by bombarding 10 stacked foils each having 5 mg/cm² of In on ¼ mil. Al foil, giving ~1 MeV steps in α-particle energy (a range-energy curve for Ag, $Z = 47$ was used for In $Z = 49$). It was possible to rotate each one of the foils in turn into the source position in the spectrometer, observations of a given reaction being made by isolating the corresponding radiation in the spectrometer and then sweeping through the 10 activated foils to obtain a counting rate for each foil ∝ the reaction cross-section for α-particles of the energy appropriate to that foil. Errors arise from inhomogeneity of the cyclotron beam, non-uniformity of foil thickness, straggling, variation in the spectrometer focusing current and source geometry, and counting statistics. The rising portion of the (α, n) excitation curve corresponded well to theoretical estimates (after Weisskopf) of capture cross-sections for α-particles. L. R. SHEPHERD

539.172.3

1216. Photo-fission of uranium with possible emission of a beryllium nucleus. F. K. GOWARD, E. W. TITTERTON AND J. J. WILKINS. Letter in *Nature, Lond.*, **164**, 661 (*Oct.* 15, 1949).

Quarternary fission has been observed in a U-loaded Ilford D_1 emulsion, irradiated by 23 MeV synchrotron γ-rays. 2 α-particles were emitted with energies 9·5 MeV and 10·5 MeV and angular separation 7°. It is assumed that a Be^8 nucleus was actually emitted in the fission and disintegrated into the α-particles. A value of 85 ± 25 keV is deduced for the Be^8 disintegration energy from the observed energies and angular separation. Only one quaternary fission was found in the 10 000 photo-fissions studied.

L. R. SHEPHERD

539.172.3

1217. Confirmation of Cl^{39} activity. R. N. H. HASLAM, L. KATZ, H. E. JOHNS AND H. J. MOODY. Letter in *Phys. Rev.*, **76**, 704 (*Sept.* 1, 1949).

Pure A at 10 atm. pressure was irradiated with γ-rays from a 23 MeV betatron. 110 min A^{41} activity was detected and a shorter period β^- activity of $55{\cdot}5 \pm 0{\cdot}2$ min was obtained on a glass-wool Sb filter through which the gas was passed. Careful chemical separation confirmed that this was a Cl isotope, produced by reaction $A^{40}(\gamma, p)Cl^{39}$. The 4 min activity previously ascribed to A^{39} could not be found, but there was some evidence of a long period activity, possibly due to A^{39} formed in the decay of Cl^{39}. Al absorption measurements indicated a value of 2·5 MeV for the energy end-point of the Cl^{39} β-spectrum. L. R. SHEPHERD

539.172.3 : 539.152.1

1218. (γ, α) reaction of C^{12} and the alpha particle model of light nuclei. V. L. TELEGDI AND M. VERDE. *Helv. Phys. Acta*, **22** (*No.* 4) 380–5 (1949) *In German.*

The disintegration of C^{12} by γ-rays of ~18 MeV is treated as a true photo-effect, i.e. absorption of the quantum with formation of a C^{12*} in the continuum, followed by α-particle emission with formation of Be^{8*} (3 MeV excitation), Be^8 or $2He^4$. The ground state of C^{12} is represented by 3 α-particles, elastically bound, in the form of an equilateral triangle. For symmetry reasons electric quadrupole radiation is assumed to cause the transition. The assumption that Be^{8*} with $J = 2$ is the final state leads to a calculated variation of relative cross-section with γ-ray energy similar to that observed. The parameters can be chosen to make the peak cross-section

fall at the observed position of ~ 18 MeV; its value at this energy then works out to be $\sim 10^{-29}$ cm², in rough agreement with expt. A. P. FRENCH

539.172.3 : 778.3

1219. Investigation of nuclear photoprocesses in light elements with the photographic method. H. WÄFFLER AND S. YOUNIS. *Helv. Phys. Acta*, **22** (*No.* 4) 414–17 (1949) *In German.*

For the study of photodisintegrations in light nuclei ($Z \leqslant 10$) nuclear track emulsions were loaded with H_2O and D_2O up to saturation of the gelatine and 200 μ thick emulsions were exposed in the water swollen state to Li-γ-radiation. The measurement of the relationship between the number of developed grains and residual range of proton tracks shows an increase of fading with increasing proton energy and with increasing time intervals between exposure and development, which has to be considered in such experiments. The following photodisintegration tests were carried out in dry and wet emulsions using the 17·5 MeV and 14·8 MeV components of Li-γ-rays and preliminary results on total cross-section values are given: (*a*) $C^{12}(\gamma,n)2\alpha : \sigma_{tot} = \sigma(17{\cdot}5) + \sigma(14{\cdot}8) = 1{\cdot}1 \pm 0{\cdot}3 \times 10^{-28}$cm²; (*b*) $D^2(\gamma,n)p : \sigma_{tot} = \sigma(17{\cdot}5) + \sigma(14{\cdot}8) = 8 \pm 3 \times 10^{-28}$ cm². Measurements were also carried out on the angular distribution of photoprotons in D. R. H. HERZ

539.172.4

1220. The energy distribution of fission fragments from Pu^{239}. D. C. BRUNTON AND W. B. THOMPSON. Letter in *Phys. Rev.*, **76**, 848–9 (*Sept.* 15, 1949).

[See previous letter, on fission in U^{233} and U^{235}, Abstr. 6433 (1949)]. Coincident pairs of fission pulses produced by thermal neutrons in a double ionization chamber with a layer of Pu on the common cathode were amplified and their size distribution analysed. The most probable light and heavy fragment energies were found to be 94·6 and 65·2 MeV respectively, and the most probable mass ratio 1·35. A comparison of the fragment mass *v.* abundance curves obtained by this method and by chemical analysis shows that the most probable light fragment masses agree, whereas the most probable heavy fragment mass is shifted up several mass units in the physical measurement. This could mean that neutron emission takes place from the heavy fragment. [But see Abstr. 2727 (1949)]. A. P. FRENCH

539.172.4

1221. Delayed neutrons from thorium. L. G. CREVELING, J. R. HOOD AND M. L. POOL. *Phys. Rev.*, 76, 946–8 (*Oct.* 1, 1949).

Th has been irradiated with fast neutrons from the reaction Li(*d*, *n*). The ½-lives of the delayed neutron activities were found to be: 55·6, 22·0, 4·5, 1·5 and 0·13 sec with initial relative saturation intensities of 0·279, 1·00, 2·00, 1·83 and 1·75, respectively. The intensity of the 55·6 sec activity relative to the 22·0 sec activity was found to be 1·76 times greater for Th fission than for U fission. A.

539.172.4

1222. Slow neutron absorption cross-sections of the elements. M. ROSS AND J. S. STORY. *Rep. Phys. Soc. Progr. Phys.*, **12**, 291–304 (1948–49).

Based on declassified data available up to June 1, 1949. Methods of measurement, e.g. pile reactivity, velocity selector, activation, are given for all values quoted. A list of 91 references is included. L. R. SHEPHERD

539.172.4

1223. $B^{10}(n, \alpha)Li^7$-reaction with slow neutrons. A. STEBLER, P. HUBER AND H. BICHSEL. *Helv. Phys. Acta*, **22** (*No.* 4) 362–4 (1949) *In German.*

Investigation of the process using a pulse spectrograph, with BF_3 gas or a thin B layer in the ionization chamber. A. O. STANESBY

539.172.4

1224. The physics of nuclear fission. G. v. DROSTE, S. FLÜGGE, H. GÖTTE, O. HAHN, W. JENTSCHKE, K. SAUERWEIN, W. SEELMANN-EGGEBERT AND A. FLAMMERSFELD. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt. Germany*] "*Nuclear Physics and Cosmic Rays, I*," 171–224 (1948) *In German.*

A historical introduction to the subject is followed by a summary of work on the chemical separation and identification of fission products. The results are presented in a diagram, showing the chains of β-decays where these could be observed and analysed. Physical measurements of the division of mass and energy in fission, and of total energy release, are reported. Values of cross-sections for fission (thermal and fast neutrons), radiative capture (thermal neutrons) and resonance capture (epithermal neutrons) in U are given, with brief accounts of the experimental methods. There are short reports on spontaneous and induced fission of elements other than U. A. P. FRENCH

539.172.4

1225. Nuclear technique. P. HARTECK, O. HAXEL, W. HEISENBERG, K. H. HÖCKER AND K. WIRTZ. *FIAT Rev. German Sci.* (1939–46) [*Off. Mil. Govt. Germany*] "*Nuclear Physics and Cosmic Rays, II*," 142–93 (1948) *In German.*

The theoretical bases for the design of a chain reactor are summarized, and experimental assemblies that were tested for multiplication are described. These were basically (*a*) spherical assemblies, using U_3O_8 or U with D_2O, (*b*) lattice assemblies of U_3O_8 or U cubes in paraffin or D_2O, (*c*) layer assemblies of U_3O_8 or U with paraffin. Neutron density distributions produced by fast neutron sources placed in the assemblies were measured and evidence for multiplication obtained. A description is given of an experimental "boiler" built in the light of earlier expts.; it was in an Al cylinder 210 cm dia. and 210 cm high. This was lined with graphite ~ 40 cm thick and contained a lattice of 5 cm U cubes suspended in D_2O. A self-sustaining reaction was not quite achieved. Problems of control and stability in a critical assembly are discussed. Theoretical and experimental conclusions about the contributions of fast neutron fission processes to a reactor are presented. The question of the optimum geometrical arrangement to avoid resonance capture of neutrons in U is considered, and values of the multiplication factor are given for various arrangements of layers, cylinders and spheres. The separation of D and U^{235} on the technical scale is discussed, with special ref. to distillation and exchange methods for D. A. P. FRENCH

539.172.4

1226. Production of C^{14} in a nuclear reactor. L. D. NORRIS AND A. H. SNELL. *Nucleonics*, **5**, 18–27 (*Sept.*, 1949).

C^{14} was formed by the reaction $N^{14}(n, p)C^{14}$ in a concentrated solution of pure NH_4NO_3, which was pumped along an Al tube running through the core of a uranium-graphite reactor. The C^{14} was oxidized to CO and CO_2 and these gases were evolved from the solution, together with O, N and other gases, in a separation tank outside the pile. The gases were dried and the CO_2 absorbed in $Ba(OH)_2$ solution. The CO was first converted to CO_2 by passing it through CuO heated to 900°C, and this also was absorbed in the $Ba(OH)_2$. Mass spectrograph studies showed that the isotopic concentration of C^{14} in the $BaCO_3$ precipitated by the original CO_2 was $< 5\%$, while that from the CO was up to 40%. The origin of the inactive C is not known. A total of 440 millicuries (88 mgms) of C^{14} was prepared in this way. L. R. SHEPHERD

539.172.4

1227. Chemical state of radioactive phosphorus (P^{32}). F. E. WHITMORE. Letter in *Nature, Lond.*, **164**, 240 (*Aug.* 6, 1949).

When produced by fast neutrons on Na_2S or on thiourea, the P^{32} was nearly all in an oxidized state. Using CS_2 or S as target, a large fraction was in elemental form. B. ROSE

539.172.4

1228. On the tripartition and quadripartition of uranium nuclei. R. CHASTEL AND L. VIGNERON. Letter in *Phys. Rev.*, **76**, 870 (*Sept.* 15, 1949).

Attention is drawn to several papers by the writers and their colleagues [Abstr. 1629, 2241 (1947); 747, 1654, 1655, 3931 (1948)] which appear to have been overlooked in recent publications on this subject.

A. P. FRENCH

539.172.4

1229. A cloud-chamber study of fission fragment ranges in air. J. K. BØGGILD, L. MINNHAGEN AND O. B. NIELSEN. Letter in *Phys. Rev.*, **76**, 988–9 (*Oct.* 1, 1949).

A cloud chamber study is described in which the ranges in air of U^{235} fission fragments from 40 events have been measured. The apparatus was calibrated using Po α-particles and with the protons from the slow-neutron disintegration of N^{14} as a secondary standard. The U α-groups offered a further check.

J. G. WILSON

539.172.4

1230. Mass assignment of xenon activities produced in fission. S. THULIN, I. BERGSTRÖM AND A. HEDGRAN. Letter in *Phys. Rev.*, **76**, 871–2 (*Sept.* 15, 1949).

After neutron bombardment of U_3O_8, the gaseous fission products were led to the ion source of a mass spectrograph and the active isotopes were collected on an Al plate. The distribution of activity along the plate was measured at various subsequent times, and confirmed the mass assignments given by Seaborg [Abstr. 2054 (1949)]. Quantum and β-particle energies were measured by β-spectrometer for Xe^{133}, Xe^{135} and Cs^{138}. A. P. FRENCH

ATOM AND MOLECULE BEAMS MESONS . NEUTRONS 539.18

539.18

1231. On the multiple production of mesons. K. SAWADA AND S. TAKAGI. Letter in *Progr. Theor. Phys.*, **4**, 239–40 (*April–June*, 1949).

This is calculated for pseudoscalar mesons on the Tomonaga–Schwinger formalism. Formulae are given for the production of groups of neutral mesons by a neutral meson impinging on a nucleon, and for the production of groups of charged mesons by a nucleon. The results differ from those of Lewis *et al.* [Abstr. 1152 (1948)]. E. P. GEORGE

539.18

1232. On the γ-decay of neutral meson. H. FUKUDA AND Y. MIYAMOTO. Letter in *Progr. Theor. Phys.*, **4**, 235–6 (*April–June*, 1949).

The results are given of a re-calculation of the life-time of this process based on the Tomonaga–Schwinger formalism. E. P. GEORGE

539.18

1233. The capture of mesons. II. B. BRUNO. *Ark. Fys.*, **1**, *Paper* 2, 19–37 (1949) *In English.*

The results of a previous calculation [Abstr. 441 (1949)] are applied to the process $\pi^- + p \rightarrow n$ involving π instead of μ-mesons. A modification is required because of the change of mass and also the higher probability of disruptive processes in the α-particle model used. Further, the probability of the process $\pi^- + p \rightarrow n + h\nu$ is evaluated, and the cross-section is found to be of the same order as the other for vector mesons, and probably for other types of mesons. This would seem to disagree with the experimental evidence on the number of stars produced on the absorption of π-mesons. The influence of nuclear binding is discussed, and justifications given for the use of the α-particle model. G. J. KYNCH

539.18

1234. On the μ-meson capture. M. TAKETANI, S. NAKAMURA AND M. SASAKI. Letter in *Phys. Rev.*, **76**, 852 (*Sept.* 15, 1949).

Supplement to previous work [Abstr. 5945 (1949)]. The Z-dependence of the capture probability, the excitation energy of the nucleus, and the possible interaction schemes between mesons, leptons and nucleons are discussed. E. P. GEORGE

539.18

1235. Elementary particles. K. FUTSCHER. *Phys. Bl.*, **5** (*No.* 6) 258–67 (1949) *In German.*

A review, including an exhaustive bibliography, of the published properties of elementary particles and the light nuclei up to He^4. J. G. WILSON

539.18 : 530.145

The application of Dyson's methods to meson interactions. *See Abstr.* 719

539.18 : 537.591

Phenomenological treatment on the production of cosmic-ray mesons. *See Abstr.* 1029

539.181

1236. Analysis of velocity distribution in a molecular beam by measurement of time of flight. F. KNAUER. *Z. Phys.*, **126** (*Nos* 3–4) 319-35 (1949) *In German.*

A molecular beam of K was interrupted periodi-

cally, and its presence shown by means of a glowing W wire (by using measurement of resulting ion-current). Each time, after establishing the full beam, the ion-current does not rise immediately but after a time lag, and then only gradually because of the velocity distribution of the atoms in the beam. The time differential of the ion-current gives the velocity distribution. Differentiation was carried out electrically, and the velocity distribution curve was obtained on an oscillograph and recorded photographically. In the case of high beam concentrations the well-known deviation from the modified Maxwell distribution was observed. Principles and experimental details are given, together with oscillographic records. F. LLEWELLYN JONES

539.181 : 539.152.1

1237. A new molecular beam resonance method. N. F. RAMSEY. Letter in *Phys. Rev.*, **76**, 996 (*Oct.* 1, 1949).

If an oscillating field is applied only at the entrance and exit of the space in which molecular states are investigated, exact transition probabilities can be derived theoretically. Resonance curves are sharper, nor are they broadened by irregularities in the homogeneous field. This technique can be applied where the oscillating field does not penetrate the region under investigation. J. JACOBS

539.185

1238. Introduction to the theory of diffusion and slowing down of neutrons. IV. R. E. MARSHAK, H. BROOKS AND H. HURWITZ, JR. *Nucleonics*, **5**, 59–68 (*Aug.*, 1949).

See Abstr. 7302 (1949). Improvements on the simple age theory are discussed, in particular the extensive use of Laplace transform methods which enable higher harmonics of the neutron distribution function to be included. The space distribution for a point source is shown (for a given "age") according to age theory and the corrected version; the latter has a more pronounced tail. The transition from Gaussian to exponential shape at large distance from the source is considered briefly. The problem of slowing down with capture is treated by age theory for the case where the cross-section varies slowly with energy. Methods for dealing with narrow resonances are outlined. A. P. FRENCH

539.185

1239. Radiation on impact between fast neutrons and protons. I. POMERANCHUK AND I. SHMUSHKEVICH. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 4) 499–502 (1949) *In Russian.*

Angular distribution for elastic collisions at large relative velocities differs whether exchange or ordinary forces act; in the latter case angles are small, in the former case mainly near 180°. Under exchange forces the wave vector changes more, hence greater dipole moment and intensity. Calculations verify that dispersion cross-section is larger, especially at high velocities. Using a simple potential function independent of spin and treating the exchange effect as a small perturbation, matrix elements for transition with emission are calculated to give scattering cross-section. Total cross-section σ_e obtained from experiment, taking complete diameter for elastic scattering. Calculated cross-section with quantum emission for fast neutrons scattered by nuclei $\simeq 10^{-27}$ cm² for N and C, 10^{-25} for Pb. If during collision of high energy relativistic protons with O or N nuclei in upper atmosphere such exchange forces occur, an enormous number of photons must be emitted. These processes may be important in forming soft components of cosmic rays. J. JACOBS

539.185

1240. The dependence of the absorption of thermal neutrons on their velocity. W. RAMM. *Z. Naturforsch.* **4a**, 245–57 (*July*, 1949) *In German.*

The temp.-dependence of the ratio of neutron density in a medium to the density in a small cavity made in an absorbing material placed in the medium is a function of the position and width of any resonance level in the absorber. A suitable approximation to the 1-level Breit–Wigner formula is used to evaluate the effect quantitatively. A description is given of expts. (performed 1942) in which neutrons in thermal equilibrium with paraffin at 20°C and 200°C respectively were used to activate Ag detectors (*a*) unshielded, and (*b*) sandwiched between layers of absorber. Conformity to the $1/v$ law appeared to hold for B, Cl, Mn, Fe, Co, Cu, Ag and Dy; observed deviations for Cd, Sm, Eu, Gd and Hg were used to obtain approx. values of E_r and Γ for these elements. The method is insensitive to resonances above ~ 1 eV, and does not compare in accuracy with time-of-flight techniques, but has an advantage over the latter in that true absorption is measured, rather than absorption + scattering. A. P. FRENCH

539.185

1241. On the primary spectrum of the fast neutrons of a (Ra α + Be)-source and their inelastic collisions in Be, Bi and Pb. M. TEUCHER. *Z. Phys.*, **126** (*No.* 5) 410–21 (1949) *In German.*

The energy spectrum was obtained from the ranges of knock-on protons in a nuclear emulsion. The cross-sections of Be, Bi and Pb for inelastic $(n, 2n)$ scattering were determined using a pulse ionization chamber coated with a layer of U or Th to be 0·32, 1·33 and 1·39 (U indicator) and 0·47, 1·5 and 1·75 barns (Th indicator) respectively.

A. O. STANESBY

539.185

1242. On β-decay of the neutron. V. B. BERESTETSKII AND I. YA. POMERANCHUK. *J. Exp. Theor. Phys., USSR*, **19**, 756–7 (*Aug.*, 1949) *In Russian.*

A free neutron can suffer β-decay, period usually estimated as 15–30 min from periods of light nuclei. But conditions in nucleus are not the same as for free-particle in some theories of β-decay. On the basis of pseudoscalar theory the probability of β-decay of neutrons to probability of nucleus with same limit of β-spectrum is of order 10^{-3} or 10^{-4}. Experiment suggests that period is > 15 min; the calculated angular distribution of electrons and neutrinos is not in disagreement with experiment.

J. JACOBS

539.185

1243. Erratum: The scattering of slow neutrons by paramagnetic crystals. I. W. RUDERMAN, W. W. HAVENS, JR., T. I. TAYLOR AND L. J. RAINWATER. *Phys. Rev.*, **76**, 434 (*Aug.* 1, 1949).

Typographical error in Abstr. 6448 (1949).

539.185

1244. On the polarisation of slow neutrons. J. STEINBERGER AND G. C. WICK. Letter in *Phys. Rev.*, **76**, 994–5 (*Oct.* 1, 1949).

Measurements are made of the transmission of a beam of slow neutrons through a slab of Fe which is alternately unmagnetized and then magnetized in a direction perp. to the neutron beam; and from the results the value of Bloch's polarization cross-section is determined. This value is found to be 3·1 barns, which is larger than the latest theoretical value by a factor of about 3. It is shown, however, that by reconsidering the wave functions of the *d* electrons and assuming a value of 1 barn for the incoherent scattering cross-section of the Fe nucleus, theory and experiment are brought into satisfactory agreement.

J. THEWLIS

539.185 : 530.145.7

1245. Scattering of polarised neutrons by protons. A. B. BHATIA. Letter in *Nature, Lond.*, **164**, 662 (*Oct.* 15, 1949).

Additional information about nuclear interactions would be obtained from the depolarization *P* of a polarized beam of neutrons when it is scattered by unpolarized protons. For a central force the phase shifts of the singlet and triplet states could be found separately if the angular distribution of *P* and the cross-section could be measured. With tensor forces an azimuthal variation of *P* appears which is calculated as ½% at 1 MeV and 40% at 100 MeV for one particular potential. This type of measurement may permit a determination of details of the non-central interactions. G. J. KYNCH

539.185 : 537.133

1246. The signs of the magnetic moments of neutron and proton. E. H. ROGERS AND H. H. STAUB. Letter in *Phys. Rev.*, **76**, 980–1 (*Oct.* 1, 1949).

The relative signs have been found by obtaining nuclear resonances in purely rotating magnetic fields derived from two pairs of crossed coils placed at right angles to one another geometrically and fed by two r.f. currents differing in phase by 90°. The moments were found to be of opposite sign and by establishing the actual direction of the constant H_0 field and the true sense of rotation of the r.f. field, it was shown that the proton moment is positive and the neutron moment is negative. G. F. HODSMAN

539.185 : 539.16.08

1247. A method for determining the absolute strength of a Ra–Be neutron source. F. ALDER AND P. HUBER. *Helv. Phys. Acta*, **22** (*No.* 4) 368–71 (1949) *In German.*

A variation of the Mn bath method is described by which activity measurements are made on the Mn at 2 different concentrations. The effect of capture by H_2O can then be eliminated. The correction for escaping neutrons is found by measuring the neutron densities at the boundary with and without Mn in solution. In the latter case the escape correction is known from the theory of neutron distributions in water, so that escape in the presence of Mn can be computed. A yield of ~ 6 300 neutrons/mc/sec is quoted for the source used. A. P. FRENCH

539.185 : 778.3

1248. Thermal neutron counting by the photographic method. C. HAENNY AND O. KLEMENT. *Experientia*, **5** (*No.* 7) 281–2 (1949) *In French.*

The use of photographic plates loaded with B and Li to measure thermal neutron fluxes, by utilizing the (n, α) reactions, is discussed. Good agreement was obtained between flux measurements made with the B emulsions and those made with Li. A value of 0·102 was found for the ratio of the reaction cross-section of Li to that of B. L. R. SHEPHERD

539.185.1

1249. A determination of the binding energy of the deuteron and of the mass of the neutron from the nuclear photo-effect in deuterium. P. MEYER. *Z. Phys.*, **126** (*Nos* 3–4) 336–43 (1949) *In German.*

A D-filled proportional ionization chamber was bombarded with 2·620 MeV γ-rays of ThC″ and the energies of the protons from the reaction $D(\gamma, n)p$ measured (= 216·8 ± 2·2 keV): the ion chamber was calibrated by allowing the electrons produced along a known path length of a beam of α-particles to enter it. The calc. D binding energy was 2·186 ± 0·005 MeV, the mass of the neutron 1·008939 ± 0·0000066 ($O^{16} = 16$), and the neutron-proton mass difference 0·000809 ± 0·0000057 (753 ± 5·5 keV).

A. O. STANESBY

STRUCTURE OF SOLIDS 539.2

539.215.4 : 531.72

1250. Particle size and pore structure of finely ground coal chars. R. L. BOND AND F. A. P. MAGGS. *Fuel*, **28**, 172–5 (*Aug.*, 1949).

It is shown that the fine structure of the char acts as a molecular sieve penetrable to small molecules, such as methanol, but impenetrable to large ones, such as dibutyl phthalate. The immersion of the powdered char in a liquid of sufficiently large molecular volume therefore leads to the generation of a wetting energy which is $\propto$ the external surface area of the particles. The "apertures" of the molecular sieve can be reduced by the action of heat and, in fact, on heating a powder to a sufficiently high temp. it becomes impenetrable to the molecules of all of the liquids used in the experiments. Heating to still higher temps. caused a smoothing of the external surface. These observations permit estimates to be made of the particle size and surface roughness. It is shown also that the size range of the apertures is quite small, and a method of estimating the distribution curve is developed. A.

539.217

1251. Diffusion and self-diffusion in chemically composite substances. I. YA. I. FRENKEL. *J. Exp. Theor. Phys., USSR*, **19**, 814–18 (*Sept.*, 1949) *In Russian.*

The mechanism of the partial diffusion is considered in compounds, which is connected with the dissociation of the molecules and with the independent displacement of the dissociation products. The problem of the reactive diffusion in binary systems is stated in terms of the hole theory. The discussion

deals with binary ionic crystals, molecular crystal lattices, "partial" diffusion, and exchange or substitution of matter before outlining the mechanism of the reactive diffusion. B. F. KRAUS

539.22 : 531.19

1252. Errata: On the order-disorder transition in solids. I–II. Y. Mutō. *J. Chem. Phys.*, **16,** 1175 (*Dec.*, 1948). Abstr. 3465–6 (1948).

539.22 : 532.782

1253. Transitions in supercooled metallic solutions. G. Borelius. *Physica*, **15,** 135–47 (*April*, 1949).

An account of the energetics and kinetics of disorder-order transformations and precipitation. The theoretical predictions are compared with experimental results on the heat capacity of CuZn alloys, calorimetric measurements on CuAu and PbSn and resistance measurements on AuPt. A. E. De BARR

539.22 : 669

1254. The ordering reaction in Co–Pt alloys. J. B. Newkirk, A. H. Geisler and D. L. Martin. Letter in *J. Appl. Phys.*, **20,** 816 (*Aug.*, 1949).

539.23

1255. Oriented arrangements of thin aluminium films formed on ionic substrates. T. N. Rhodin, Jr. *Disc. Faraday Soc.* (*No.* 5) 215–33 (1949).

An apparatus is described for evaporating Al on to ionic substrates at various temps. in vacuo, or in the presence of gases, the condensation rate being measured with a microbalance. The structure of the thin Al films was strongly influenced by the nature, geometry and temp. of the ions in the base. The degree of orientation of the film is related to a binding energy characteristic of the substrate, of the same order as van der Waals' binding between a single atom and an infinite ionic surface. J. A. FRANKS

539.234

1256. Production of thin metal and salt layers by evaporation in vacuum. K. Rohn. *Z. Phys.*, **126** (*Nos* 1–2) 20–6 (1949) *In German.*

A description is given of the method and apparatus used to deposit by evaporation on a glass plate a uniformly thick reflecting layer of Ag and then, on top of this layer, a thin, transparent wedge of LiF. The thickness of the wedge was determined from the interference rings formed by illuminating the layer at glancing incidence with linearly polarized Hg light. By varying the pressure in the evaporation chamber from 10^{-4} to 10^{-1} mm Hg and using either N or A it is shown that for the thickness of the LiF layer to agree with that expected in accordance with the distance between heater and plate, the m.f.p. of the gas must be $>$ the distance of travel of the evaporated molecules. S. WEINTROUB

539.26 : 548.53

Precipitation in alloys. *See Abstr.* 1357

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31 : 669

1257. Mechanical properties of metals. N. F. Mott. *Physica*, **15,** 119–34 (*April*, 1949).

A short account of the dislocation theory of the properties of metals. Slip, work hardening, impurities, recrystallization and recovery and grain boundary effects are considered. A. E. De BARR

539.313

1258. Stress-strain relations for uniform monotonic deformation under triaxial loading. J. H. Palm. *Appl. Sci. Res.*, **A2** (*No.* 1) 54–92 (1949).

539.313

1259. Stress-strain relations and necking criteria for triaxial loading, two principal stresses being equal. J. H. Palm. *Appl. Sci. Res.*, **A1** (*Nos* 5–6) 353–77 (1949).

539.313

1260. An investigation of the mechanical properties of materials at very high rates of loading. H. Kolsky. *Proc. Phys. Soc., Lond. B,* **62,** 676–700 (*Nov.*, 1949).

A method of determining the stress-strain relation of materials when stresses are applied for times of the order of 20 μsec is described. The apparatus employed was a modification of the Hopkinson pressure bar, and detonators were used to produce large transient stresses. Thin specimens of rubbers, plastics and metals were investigated and the compressions produced were as high as 20% with the softer materials. It was found that whilst Perspex recovered almost as soon as the stress was removed, rubbers and polythene showed delayed recovery, and Cu and Pb showed irrecoverable flow. The phenomenon of delayed recovery is discussed in terms of the theory of mechanical relaxation and memory effects in the material. A.

539.319 : 535.55

1261. Investigation of stressed conditions in transparent solid models in a beam of parallel rays of polarized light. N. I. Prigorovskiĭ and A. K. Preĭss. *Izv. Akad. Nauk, SSSR Otdel. Tekn. Nauk* (*No.* 5) 686–700 (*May*, 1949) *In Russian.*

A stress-optical measuring method carried out on thin plates cut from the 3-dimensional models "frozen" under load. Each point of such a "cut" conserves the elastic deformation obtained prior to cutting-off, and is considered as an optically anisotropic crystal, and the whole cut (and model) as an accumulation of a great number of heterogeneous and differently orientated crystals. The optical properties of any point of the model are in a definite relation to its stressed state. The methods of crystal optics (in particular, E. S. Fedorov's universal method; 3 books quoted) may be applied; it is explained how to deduce the characteristics of the stressed state from optical data. The material used is a plastic mass, transparent and without initial optical activity. The most important characteristic of the material is its 2-phase structure; on heating of the stressed model, phase *A* of the material is softened, whereas phase *C* remains elastic. Thus the stresses are, on heating, borne by phase *C*, forming an elastic skeleton. Cooling down of the model results in phase *A* re-solidifying and "freezing" the stressed state. This is the condition preserved after removal of the load. Extensive material is given to show the positive results of the tests of the method, interference pictures as well as comprehensive tables of the main stress cases of technical importance.

B. F. KRAUS

539.32 : 541.64

1262. A method of measuring some dynamic elastic constants and its application to the study of high polymers. K. W. HILLIER. *Proc. Phys. Soc., Lond. B*, **62**, 701–13 (*Oct.*, 1949).

The preliminary work on the measurement of velocity of propagation and attenuation of longitudinal sound oscillations in high polymer filaments already described by Hillier and Kolsky [Abstr. 2151 (1949)] has been continued. It was concluded in that paper that temp. control would be advantageous, and that by varying the temp. and the frequency of oscillations more useful information could be acquired. An apparatus is described whereby the velocity of propagation and the attenuation of longitudinal oscillations throughout the range 0° to 50°c and 500 c/s to 30 kc/s can be measured. The results obtained with one material, polythene, are discussed in terms of several theories of the elasticity of high polymers, and the constants of the several equations considered are calculated from the data. A.

539.32 : 548.0

Elastic constants of sodium chlorate, sodium bromate, and lithium fluoride. *See Abstr.* 1330–1

539.32 : 548.

Calculation of Poisson coefficients of KH_2PO_4. *See Abstr.* 1332

539.32.08 : 537.228.1

1263. Elasticity measurements on piezo-electric crystals by the method of Schäfer and Bergmann. F. JONA. *Helv. Phys. Acta*, **22** (*No.* 4) 397–400 (1949) *In German.*

The elastic constants of KDP, Rochelle salt and $NaClO_3$ are obtained from ultrasonic diffraction patterns. They differ somewhat from the constants calculated from the resonance frequencies of bars and plates, but an explanation of the discrepancies is suggested. H. J. H. STARKS

539.37

1264. The strain field of a dislocation. G. LEIBFRIED AND K. LÜCKE. *Z. Phys.*, **126** (*No.* 5) 450–64 (1949) *In German.*

This is calculated by two different methods, firstly on the basis of elasticity theory and secondly by simplifying and extending a treatment due to Peierls [Abstr. 619 (1940)], which takes into account the atomic structure. The two solutions practically agree. A comparison is finally made with the original solution of Taylor. E. P. WOHLFARTH

539.374

1265. Flow phenomena in rubber. II. Flow curves for GR-S rubber. L. R. G. TRELOAR. *Trans. Instn Rubb. Ind.*, **25**, 167–71 (*Oct.*, 1949).

The flow of GR–S rubber at various temps. has been examined by means of the biconical rotor type of Mooney plastometer. Unlike the natural rubber previously studied [*ibid.*, **24**, 92 (1948)], the shape of the flow curves was consistent with the Ostwald–de Waele relation. Values of activation energy for flow, determined from the temp. coeff. of flow rate (at constant stress), averaged 10·2 kcal./mole. A.

539.374

1266. Plastic deformation and destruction of polycrystalline metals in tension. II. The elongation curve of pure metals. G. N. KOLESNIKOV AND OTHERS. *J. Tech. Phys., USSR*, **19** (*No.* 1) 62–75 (1949) *In Russian.*

An investigation of the stress-strain diagrams of Sn, Cd, Zn, Mg, Pb, Al, Cu and alpha-Fe at temps. ranging from 78°K to within 0·8° of the temp. of fusion or phase-change. It is found that in the majority of cases the stress-strain curves of the pure metals fall into two groups of "low temp." and "high temp." metals respectively. The "high temp." stress-strain curve is specially investigated.

INDEX AERONAUTICUS

539.374

1267. Deformation resistance in the plastic flow of polycrystalline metals. P. O. PASHKOV. *J. Tech. Phys., USSR*, **19** (*No.* 2) 261–70 (1949) *In Russian.*

Experimental and mathematical analysis of the problem indicates the possibility of obtaining a single standard of strength for considerable plastic deformation and any condition of stressing. A suitable method of strength analysis is developed and verified on a number of examples of 2- and 3-dimensional stress problems, and expressions are given for hardness, torsion, etc., considerably widening the scope of strength analysis under conditions of compound stress. INDEX AERONAUTICUS

539.374

1268. Plastic deformation of glass during scratching. J. F. H. CUSTERS. Letter in *Nature, Lond.*, **164**, 627 (*Oct.* 8, 1949).

Photomicrographs show that, when scratched with diamond, glass can form turnings like those formed by ordinary plastic materials. [See also Abstr. 1280 (1950)]. R. O. DAVIES

539.374

1269. Rectilinear flow of non-Bingham plastic solids and non-Newtonian viscous liquids. I. J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 595–611 (1949).

The stress-rate of shear relationship, expressed in parametric form, for incompressible and isotropic materials leads to a single second-order differential equation for rectilinear flow with zero pressure gradient. Complete solutions determine all possible velocity distributions and one corresponding to a 4-fold infinity of stress-rate of shear relationship is established. J. E. CAFFYN

539.374.3

1270. Stresses and strains in tube-drawing. H. W. SWIFT. *Phil. Mag.*, **40**, 883–902 (*Sept.*, 1949).

A theoretical examination is made of "empty sinking" and "pressure sinking." Changes in thickness are taken into account, and the influence of friction and strain-hardening is considered. The results are compared with those of the simpler theory in which changes in thickness are neglected. There is little difference when applied to tube-drawing operations, but the simpler theory cannot be applied with equal confidence to tube-sinking. The theory compares well with the few experimental results available.

L. S. GODDARD

539.42

1271. A statistical theory of fracture. J. C. FISHER AND J. H. HOLLOMON. *Trans. Amer. Inst. Min. Metall. Engrs*, **171**, 546–61 (1947).

An attempt, using statistical analysis, to rationalize the size effect in solids, the scatter of fracture-stress values and the dependence of fracture stress upon strain, and to suggest a quantitative relation between the structure and the fracture stress. The material is assumed to have an idealized structure, namely that of an elastic solid containing many cracks which are oriented at random and assumed to be thin and disc-like, with elliptic cross-sections.

APPLIED MECHANICS REVIEWS

539.42

1272. Fracture and strength of solids. E. OROWAN. *Rep. Phys. Soc. Progr. Phys.*, **12**, 185–232 (1948–49).

A general and comprehensive review of the subject, covering in particular the more modern theories, including the author's, on ultimate stress, brittle fracture, ductile fracture, notch brittleness and fatigue. The effect of various factors and the conditions of the test on these types of fracture are dealt with in detail. G. O. BAINES

539.42

1273. Investigation of fractures produced by transient stress waves. H. KOLSKY AND A. C. SHEARMAN. *Research, Lond.*, **2**, 384–9 (*Aug.*, 1949).

The fractures obtained in Perspex of various shapes, when small charges of lead azide are detonated on the surfaces, are described and shown to be explainable by considering the reflections of the stress pulses at the free surfaces. Possible uses of this method of testing are suggested. G. O. BAINES

539.434

1274. An automatic recording apparatus for the study of flow and recovery in metals. E. N. DA C. ANDRADE AND A. J. KENNEDY. *Proc. Phys. Soc., Lond. B*, **62**, 669–75 (*Oct.*, 1949).

An apparatus is described which records continuously on photographic paper the extension-against-time curve of a metal wire creeping under stress. The length and time scales are recorded on the paper at the same time as the extension, so that deformation of the paper during development and drying does not affect the accuracy of the record, which allows an extension of up to 10 cm to be read to within 0·02 mm. The apparatus also automatically removes and restores, repeatedly if desired, the load at times which can be set before the start of the experiment. A.

539.501

1275. Rheological properties of polystyrene below 80°C. B. MAXWELL AND L. F. RAHM. *Industr. Engng Chem.*, **41**, 1988–93 (*Sept.*, 1949).

A study by means of stress relaxation tests at various elongations and temps. and by creep tests at various loads and temps. The results indicate that there are two mechanisms of stress relaxation and creep. The first is the slipping of chain segments and the second is crazing. A new method of measuring crazing is described, and detailed studies of the relation of crazing to time, temp., stress and strain are reported. It is concluded that a specific critical elongation must be reached before crazing takes place. This elongation is independent of temp. but is affected by certain organic solvents. A.

539.50

1276. Rheological properties of high-viscosity solutions of long molecules. F. H. GARNER AND A. H. NISSAN. Letter in *Nature, Lond.*, **164**, 541 (*Sept.* 24, 1949).

539.50

1277. Discontinuous flow phenomena in gelatine gels. V. R. GRAY. Letter in *Nature, Lond.*, **164**, 584–5 (*Oct.* 1, 1949).

Using a coaxial cylinder viscometer, extinction angle and double refraction were measured during stress relaxation. 3 mechanisms are distinguished: (1) stress relaxation according to Schwedoff's equation [*J. Phys.*, **8**, 341 (1889)]; (2) Maxwellian relaxation; and (3) increase of relaxation time due to setting of the gel. J. E. CAFFYN

539.501

1278. Mathematical principles of rheology. H. HENCKY. *Research, Lond.*, **2**, 437–42 (*Sept.*, 1949).

The distinction between affine and projective transformations is emphasized, the latter being used to define strain e_{ik}. Stresses σ_{ik} are related to the deformed surfaces; two states are considered: state I, stressed but in equilibrium; state II, differing from I by infinitesimal changes of stress Δs_{ik} and strain Δe_{ik}. The infinitesimal stress Δs_{ik} applied in I is assumed to be $\propto$ the increment of strain Δe_{ik}. Expressions for the increment of stress applied in I to produce the change, is given in terms of the increment of stress $\Delta\sigma_{ik}$ measured in II. The equations of motion and equilibrium for a change from state I to state II are derived for the case of an elastic solid and a Maxwellian liquid. Some simple problems are solved. J. E. CAFFYN

539.501

1279. On volume or isotropic flow as exemplified in the creep of concrete. M. REINER. *Appl. Sci. Res.*, **A1** (*Nos* 5–6) 475–88 (1949).

539.532 : 666

1280. A hardness table for some well-known types of optical glass. E. W. TAYLOR. *J. Sci. Instrum. Phys. Ind.*, **26**, 314–16 (*Sept.*, 1949).

Experiments are described in which a diamond indenter is used as a means of assigning diamond pyramid hardness numbers to 15 well-known types of optical glass. Evidence is produced to show that optical glass is subject to plastic deformation, and that when static impressions are formed in the surface the displaced material is piled up along the edges; when grooves are formed some of the material is piled up and some is removed. No evidence is forthcoming to indicate the existence on a worked glass surface of a superficial layer with differing physical properties. The results confirm the belief, current among glass workers, that crown glasses are relatively harder than the flints. [See also Abstr. 1268 (1950)]. A.

539.61

1281. The nature of adhesion. S. MOSES. *Industr. Engng Chem.*, **41**, 2338–42 (*Oct.*, 1949).

Analysis of the data on the adhesion of polystyrene, VYHH, and methyl methacrylate systems to

aluminium alloy has shown that adhesion in the cases investigated depends on the presence of a fluid, or quasi fluid, or mobile state at or near the film-metal interface. The data were obtained by ultrasonic means. An explanation of simple examples is offered in support of the concept of mobility. A.

539.62

1282. Frictional properties of some plastics. K. V. SHOOTER AND P. H. THOMAS. *Research, Lond.*, **2**, 533–5 (*Nov.*, 1949).

The frictional properties of 4 plastics—Teflon, polyethylene, polystyrene and Perspex—have been examined over a range of temps. The coeffs. of friction increase from Teflon to Perspex in the above order and it is suggested that the differences found may be explained in terms of the chemical structures of the polymers. At the low rate of sliding used in the measurement of the coeffs., the frictional heating is insufficient to affect appreciably the frictional properties of the plastics. At higher rates of sliding, sufficient heat may be developed to produce marked softening at the rubbing interface; this effect is used in the process of friction welding. Teflon differs from the other 3 plastics in that even under the most severe conditions it cannot be friction welded. The frictional properties of Teflon are exceptionally good. A.

539.62

1283. Energy dissipation in solids at sonic and ultrasonic frequencies. G. G. PARFITT. Letter in *Nature, Lond.*, **164**, 489–90 (*Sept.* 17, 1949).

Previous experimental work has shown that, over a wide range of materials, a fractional energy loss per vibration cycle occurs which is independent of the frequency. Tests have now been made on certain high polymers in the glassy state, vibrated in longitudinal resonance, the rods being 20 cm long and the tests being made within the range 5–60 kc/s. In addition, torsional and flexural vibrations were investigated on the same rods. Perspex, unplasticized and plasticized with 5% dibutyl phthalate, and polystyrene were studied at room temp., and the fractional energy loss/cycle varied little with frequency, as also did Young's modulus. Perspex gave losses about 6× those of polystyrene. A. C. WHIFFIN

539.62

1284. Damping and losses in solid bodies. 1. General theory. E. SKUDRZYK. *Öst. Ingen. Arch.*, 3 (*No.* 4) 356–73 (1949) *In German.*

The fundamental elastic equations for the deformations of solids are derived, and the elastic after-effects as well as elastic long-distance effects (temp. equalizations between compressed and extended portions of a material) are discussed. It is shown that frictional losses can only be taken into account if an infinite number of constants depending on the material are considered. Harmonic motion, however, reduces the number of constants to 2. In that case, the frictional constants can be considered imaginary parts of the elastic constants. The damping of mechanical vibrations depends on the characteristics of the 2 frictional constants; only the low frequencies sometimes make an exception owing to the predominance of hysteresis effects. In case of harmonic motion the losses can be taken into account in an exact manner by using complex elastic constants and a complex Poisson's number m. The relations between the different loss factors are derived and tabulated as a function of 2 primitive constants. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5

1285. Exchange of ions between the surface of crystals and solutions. R. M. STOW AND J. W. T. SPINKS. Letter in *J. Chem. Phys.*, **17**, 744 (*Aug.*, 1949).

The exchange of ions between the surface of $SrSO_4$ crystals and solutions has been used to measure the active surface area of the crystals by utilizing the radioactive isotopes Sr^{90} and S^{35}. The values for the areas differ by more than the experimental error, possibly because excess H_2SO_4 was used in preparing the $SrSO_4$. However, the differences may also be due to the differing radii of the ions and differing surface activity coeffs. W. R. ANGUS

541.126

1286. Note on "Qualitative experimental verification of the change of burning rate of rocket powders with radiation path length." H. MURAOUR. Letter in *J. Appl. Phys.*, **20**, 819 (*Aug.*, 1949).

Commenting on a note by Penner [Abstr. 3308 (1949)] Muraour points out that the explosion temp. calculated from the propellant composition given by Penner is about 4 000°K. Using a relation given by Muraour and Aunis [*Mem. de l'Artillerie Franç.*, **20**, 637 (1946)] the burning rate of a propellant can be predicted from its explosion temp. The burning rate given by Penner agrees more closely with an explosion temp. of 2 600°K than with the calculated value, 4 000°K. A. SCHOFIELD

541.126

1287. Reply to Muraour's letter to the editor. S. S. PENNER. Letter in *J. Appl. Phys.*, **20**, 819 (*Aug.*, 1949).

In reply to Muraour's comments (preceding Abstr.) it is stated that the composition quoted was intended only as a general indication of the type of propellant used; for security reasons fuller details could not be revealed. The explosion temp. of the propellant used was approx. 2 500°K, so that the observed burning rate agrees quite well with the formula of Muraour and Aunis. A. SCHOFIELD

541.127 : 539.155.2

1288. The relative reaction velocities of isotopic molecules. J. BIGELEISEN. *J. Chem. Phys.*, **17**, 675–8 (*Aug.*, 1949).

The rate constants for competitive reactions of isotopic molecules are considered from the theory of "absolute rates" and the collision theory. Formulae

are derived for the ratio of the rate constants and the difference in the activation energies for reactions of isotopic molecules. The difficulties in the *a priori* calculation of relative rates are pointed out and discussed. In general the rate constant for the light molecule will be > that of the heavy molecule. It is shown that the max. ratio in the rates occurs when the isotopic atom is essentially free in the activated complex. The conditions for the rate constant of the heavy molecule to exceed that of the light one are formulated. It is shown that the difference in activation energies covers the range from zero to the difference in the differences in the zero-point energies of the reacting molecules and their respective activated complexes. A.

541.127 : 536.461

1289. On the theory of burning velocities in gas-mixtures. N. MANSON. Letter in *J. Chem. Phys.*, **17**, 837–8 (*Sept.*, 1949).

Commenting on the measurements of the burning velocity of mixtures of butadiene with normal air and "helium air" (79% He, 21% O) made by Badin, Stuart and Pease [Abstr. 3174 (1949)] it is pointed out that the effect of changing the inert constituent of the gas-mixture can be explained as well by Manson's theory [Abstr. 3955 (1949)] as by that put forward in Abstr. 3174 (1949). Although the relative values of the burning velocity show good agreement between theory and experiment, there is a wide discrepancy between the absolute values, the theoretical values being high by 60–70%. A. SCHOFIELD

541.127 : 536.461

1290. Near-equilibrium criteria for complex chemical reactions during flow through a nozzle. S. S. PENNER. Letter in *J. Chem. Phys.*, **17**, 841–2 (*Sept.*, 1949).

The composition of a gas mixture capable of undergoing complex and interdependent chemical reactions lags behind equilibrium conditions when the temp. changes rapidly, as it does during flow through a nozzle. A theoretical investigation of this phenomenon has been carried out, the method being illustrated by consideration of the reaction between H_2 and F_2. Useful qualitative conclusions can be drawn, but the lack of accurate data on reaction rates limits quantitative application of the results.

A. SCHOFIELD

541.128

1291. Catalysis on non-uniform surfaces. G. D. HALSEY, JR. *J. Chem. Phys.*, **17**, 758–61 (*Sept.*, 1949).

541.128

1292. Parahydrogen catalysis by transition metals. A. COUPER AND D. D. ELEY. Letter in *Nature, Lond.*, **164**, 578–9 (*Oct.* 1, 1949).

The catalytic activity of Pd–Au alloys for parahydrogen conversion, expressed as activation energy (E) and frequency factor (A) in the expression for the first-order constant $k : A \exp(-E/RT)$, has been investigated. As the Au content is increased up to 40 atomic % values of E and of A are not appreciably altered; but as greater amounts of Au are added E abruptly rises and A rapidly diminishes. Dissolved H atoms gives analogous results. These results are interpreted on the view that the added Au or H atom passes its electron into the *d*-band of Pd. Similar reasoning explains why H atoms are strongly chemisorbed by transition metals. Extension of these explanations to studies of H overvoltage, hydrogenation, and anodic oxidation are foreshadowed. W. R. ANGUS

ELECTROCHEMISTRY 541.13

541.133

1293. The conductivities of dilute aqueous solutions of potassium ferrocyanide and calcium ferrocyanide. J. C. JAMES. *Trans. Faraday Soc.*, **45**, 855–61 (*Sept.*, 1949).

541.133

1294. Passage of current through solutions. Discontinuous variation with temperature. M.-C. OLLIVIER. *C.R. Acad. Sci., Paris*, **228**, 984–5 (*March* 21, 1949) *In French.*

The graphs of electrical conductivity against temperature, measured by an ordinary bridge method, for dilute HNO_3, Li_2SO_4, $Fe(NO_3)_3$ and NH_4NO_3 solutions all show discontinuities between 10°C and 50°C. N. CORCORAN

541.133.1

1295. Anomalous mobility of H^+ and OH^- ions. A. GIERER AND K. WIRTZ. Letter in *J. Chem. Phys.*, **17**, 745–6 (*Aug.*, 1949).

A theory of the mechanism of excess mobility of H and OH ions in water is outlined. The excess mobilities of these ions over ions of similar size and charge are expressed as u^+ and u^- where $u = u_0 f(T) \cdot \exp -(q/kT)$; $f(T)$ is a factor expressing the deviation of u from the exponential temp.-dependence and is calculated from the mole fractions of the different forms of association of water. $f(T)$ is claimed to express the number of H bonds per molecule of H_2O in the non-ice-like association forms of water. q^+ and q^- are calculated from the above equation. The excess mobility is said to be due to the occurrence of two consecutive processes: (i) Association of a water molecule to one of the H bonds of the H_3O^+ or OH^- ions. (2) Transition of a proton over the hydrogen bridge. The slow process determining the velocity cannot be decided upon on the basis of the theory presented. The anomalous pressure increase of u is explained in terms of the theory. J. O'M. BOCKRIS

541.133.1

1296. Differential diffusion coefficients of sodium ion in sodium chloride solutions. A. W. ADAMSON, J. W. COBBLE AND J. M. NIELSEN. Letter in *J. Chem. Phys.*, **17**, 740 (*Aug.*, 1949).

Results of an investigation of the differential or self-diffusion coeffs. of radioactive Na^+ in aqueous NaCl solutions, together with the results of a similar investigation for Na^+ in NaI solutions previously carried out, show that the diaphragm cell technique gives spurious results, at least in dilute solutions. This behaviour is ascribed to the surface diffusion of ions on the walls of the diaphragm pores. A possible method of correction for this error, which can be evaluated, is suggested. J. O'M. BOCKRIS

541.134

1297. The effect of centrifugal force on galvanic potentials: (a) The transference numbers of potassium iodide, (b) The iodide-iodine ion. D. A. MACINNES AND B. R. RAY. *J. Amer. Chem. Soc.*, **71**, 2987–92 (*Sept.*, 1949).

The potential, E, of a galvanic cell consisting of two I–I electrodes at two different radii in a rotor has been measured at different speeds of rotation, n. Reproducible potentials were obtained only when radial temp. gradients were eliminated and the solutions in the cell were free from suspended particles. A series of measurements were made on solutions which had a constant concentration of KI, but varying concentrations of I. For each solution values of E/n^2 were found to be accurately constant, through a range of values of n from 1 800 to 7 200 r.p.m. The ratio E/n^2 increases with the proportion of free I, a fact that is quantitatively accounted for by the presence in solution of the ionic complex I_3^-. The measurements also yielded a value of the transference numbers of PI in agreement with those obtained by the moving boundary method. A.

541.135 : 536.531 : 537.312.6

Electrolytic thermistors. *See Abstr.* 974

541.135.21

1298. Electrolytic deposits of Po in extremely dilute solutions. M. HAÏSSINSKY, H. FARAGGI, A. COCHE AND P. AVIGNON. Letter in *Phys. Rev.*, **75**, 1963–4 (*June* 15, 1949).

The distributions over the surface and in α-particle range of electrolytic and spontaneous deposits of Po from extremely dilute (10^{-10}–10^{-14}N) acid solutions on to Au, Pt, Ni and Ag were determined by applying the surfaces to nuclear emulsions. Ag showed the expected distribution at all dilutions; with Au at high dilutions the range-distribution curve was displaced towards lower ranges and broadened: Ni and Pt showed intermediate behaviour. The partial α-particle absorption is due to penetration by the Po of the surface structure of the metal.

A. O. STANESBY

541.135.5

1299. The variation of hydrogen overvoltage at various cathodes on the addition of ethyl alcohol, acetaldehyde, and acetic acid. A. WETTERHOLM. *Trans. Faraday Soc.*, **45**, 861–73 (*Sept.*, 1949).

541.135.5

1300. The kinetics of the hydrogen evolution reaction at mercury cathodes. The effect of temperature, pH, and pressure on hydrogen overpotential in aqueous, mixed and methanolic solutions. J. O'M. BOCKRIS AND R. PARSONS. *Trans. Faraday Soc.*, **45**, 916–28 (*Oct.*, 1949).

541.135.5

1301. Increase of oxygen overpotential at a platinum anode by reducing agents. A. HICKLING AND W. H. WILSON. Letter in *Nature, Lond.*, **164**, 673 (*Oct.* 15, 1949).

The presence of low concentrations of certain reducing substances is found to increase the O evolution potential at a Pt anode but not at Au, Pd, Ni or graphite anodes. The effect is apparent on adding substance to the electrolyte (a phosphate buffer solution pH 6·8), is not specific to the latter, and reaches a max. in a few minutes. The increased potential is found to decrease on prolonged electrolysis. The compounds producing the effect all contain N or S. The rise in potential was independent of c.d. as long as the limiting diffusion current for the added substance to the electrode was exceeded and O was always evolved. On washing the Pt anode in water the effect did not reappear in fresh electrolyte. Any suggestion as to the cause of the effect is as yet speculative. J. O'M. BOCKRIS

541.135.5

1302. Measurement of the capacity of the electrical double layer at a mercury electrode. D. C. GRAHAME. *J. Amer. Chem. Soc.*, **71**, 2975–8 (*Sept.*, 1949).

Recent modifications in the author's apparatus [Abstr. 2964 (1946)] for measurement of the capacity of the electrical double layer at a mercury surface in contact with aqueous salt solutions are described. The differential capacity of the electrical double layer, the surface charge density and the electrocapillary curve of mercury in N/10 KCl are presented in tabular form. A.

541.135.5 : 537.361

1303. The potential of the electrocapillary maximum of mercury. D. C. GRAHAME, R. P. LARSEN AND M. A. POTH. *J. Amer. Chem. Soc.*, **71**, 2978–93 (*Sept.*, 1949).

3 techniques are described for the determination of "isotension potentials," pairs of potentials at which the interfacial tension is the same on the 2 branches of the electrocapillary curve. A method is described for the determination of the potential of the electrocapillary max. by combining isotension potential data with measurements of the capacity of the electrical double layer. Values of the potential of the e.c. max. in N/10 potassium and sodium chlorides are obtained by these 3 methods and also by 2 other methods of which one is new. Good agreement is obtained. A value of $0{\cdot}559_0$ V is obtained for the e.c. max. potential of N/10 KCl relative to a N/10 calomel electrode, both at 25°. Essentially the same value is obtained for N/10 NaCl relative to a N/10 calomel electrode in NaCl. This value is compared with previously published values. A temp. coeff. of $-0{\cdot}0705$ mV/deg. is found for the e.c. max. potential in N/10 KCl. A.

541.135.5 : 621.352

1304. Alloy electrodes in the galvanic cell. H. JEDLICKA. *Z. Naturforsch.*, **4a**, 301–2 (*July*, 1949) *In German.*

The characteristics and uses of amalgam electrodes in particular are discussed. A potential of about 1·9 V has been found for the cell 0·3% Na in Hg/10% NaOH/CuO, whilst the cell Cl_2(carbon)/aq.NaCl/Na(Hg) yields about 3 V and works at 55% efficiency as a fuel cell. The cells Hg/aq.NH_3/Cu and Hg/$(CH_3)_4$NOH/Cu were found to behave similarly to that using Na amalgam and NaOH. The possibilities of using alkyl ammonium compounds and metal alkyls in cells are pointed out.

J. O'M. BOCKRIS

PHOTOCHEMISTRY
RADIATION CHEMISTRY 541.14

541.14

1305. The hot atom chemistry of the propyl bromides. L. FRIEDMAN AND W. F. LIBBY. *J. Chem. Phys.*, **17**, 647–52 (*July*, 1949).

The chemical effects of the recoil from the capture γ-radiation produced by the (n, γ) reaction on Br^{81} in both normal and isopropyl bromides have been investigated. A.

541.14

1306. Chemical reactions produced by very high light intensities. R. G. W. NORRISH AND G. PORTER. Letter in *Nature, Lond.*, **164**, 658 (*Oct.* 15, 1949).

The gas-discharge flash-lamp can be used to obtain a high light output for photochemical reactions. A quartz tube 1 m long, with large tungsten electrodes, gave energies up to 10 000 Joules per flash. The output is continuous down to at least 2 000 Å and at wavelengths below 3 500 Å can be increased by the addition of liquid Hg. Examples of the different behaviour of well-known photochemical systems under these high light intensities are given. With acetone and ketene a complex mixture of substances, including H_2 and a high proportion of C, was formed, instead of the usual mixture of hydrocarbons and CO. Cl and CCl_4 react to give a considerable amount of a solid product. The photochemical reaction between CO and Cl to give phosgene is reversible with variation of light intensity. Where photochemical reactions at high light intensities take different courses from those at low intensities it is probably due to the higher concentration of intermediates, and to the fact that the process is nearly adiabatic. A. J. MEE

541.14 : 577.1

1307. An isotope effect in photosynthesis. J. W. WEIGL AND M. CALVIN. Letter in *J. Chem. Phys.*, **17**, 210 (*Feb.*, 1949).

Barley seedlings and algae were grown in an atmosphere the CO_2 of which contained some $C^{14}O_2$. When the barley seedlings were illuminated the specific activity of the CO_2 in the atmosphere increased. In the algae, which were grown as a small inoculum, the specific activity of the carbon was only 81% of that of the CO_2 originally admitted. H. LONDON

541.141

1308. The kinetics of the photochemical interaction of hydrogen with chlorine. W. J. KRAMERS AND L. A. MOIGNARD. *Trans. Faraday Soc.*, **45**, 903–15 (*Oct.*, 1949).

541.144

1309. Photochemical polymerization in aqueous solution. M. G. EVANS AND N. URI. Letter in *Nature, Lond.*, **164**, 404–5 (*Sept.* 3, 1949).

Photo-sensitized polymerization in aqueous solution based on electron transfer excitation has been investigated in order to verify the hypothesis of Rabinowitch which requires that where $Fe^{+++} - OH^-$ is the photo-sensitizing system, reduction to Fe^{++} and OH radicals should take place. It is known that OH radicals produced in the ferrous iron $-H_2O_2$ reaction can initiate polymerization in compounds such as acrylonitrile, methyl methacrylate, etc. The same monomers polymerize when their solutions with $Fe^{+++} - OH^-$ are irradiated with u.v. of $\lambda >$ 300 mμ. The rate of formation of Fe^{++} leads to quantum yields of approx. 10^{-2} (for 365 mμ) for saturated solutions of acrylonitrile. The mol. wt. of a methyl methacrylate polymer obtained by this method was approx. 120 000, corresponding to a chain length of 1 200. The polymerization in dil. Fe^{+++} solutions is practically suppressed in a strong acid medium, when the $Fe^{+++} - OH^-$ equilibrium concentration becomes a min. Solutions of Fe^{+++} in the presence of F^-, Cl^-, oxalate, and citrate ions under conditions in which the concentration of the $Fe^{+++} - OH^-$ pair is minimal show photo-reduction of Fe^{+++} and polymerization occurs. Spectrophotometric measurements indicate that complexes of Fe^{+++} and these acid radicals are present and these are the active photosensitizers. $[FeBr]^{++}$ and $[FeSCN]^{++}$ complexes are inactive. Electron transfer excitation requires an energy > that corresponding to the reaction $Fe^{+++} + OH^- \rightarrow Fe^{++} + OH$ + 40 kg.-cal. in aqueous solution. The systems $Ce^{++++} - OH^-$ and $Pb^{++} - Cl^-$ are also active photosensitizers in the polymerization of vinyl compounds in agreement with their characteristic electron transfer spectra. A. J. MEE

DISPERSIONS . COLLOIDS
ADSORPTION 541.18

541.18 : 532.13

Visco-elastic behaviour. *See Abstr.* 755

541.182.5 : 535.434

1310. Studies in colloid optics. II. The sol-gel transformation of gelatin gels. P. K. KATTI. *Proc. Indian Acad. Sci. A*, **30**, 35–48 (*July*, 1949).

Investigations using light-scattering techniques are described. R. F. BARROW

541.182.5 : 539.26

1311. X-ray examination of pure alumina gel. M. H. JELLINEK AND I. FANKUCHEN. *Industr. Engng Chem.*, **41**, 2259–65 (*Oct.*, 1949).

As a continuation of earlier heating experiments on commercial alumina, wide angle and small angle studies have been made of relatively pure alumina that had been subjected to increasingly severe heat treatment. Both wide angle and small angle measurements indicate an increase in crystallite and particle size with increase in severity of heat treatment. The data seem to indicate that all heretofore suggested structures of γ-alumina are incorrect. No alternative structure is proposed. A.

541.183

1312. A note on interstital diffusion. R. M. BARRER AND W. JOST. *Trans. Faraday Soc.*, **45**, 928–30 (*Oct.*, 1949).

541.182.6

1313. Investigation of the geometrical and magnetic properties of colloid particles by the methods of magnetic and dynamic double refraction. V. TSVETKOV AND M. SOSINSKI. *J. Exp. Theor. Phys., USSR*, **19**, 543–52 (*June*, 1949) *In Russian.*

The new method presented consists in an investigation of the birefringence and dichroism of a colloidal solution in a stationary magnetic field, in a rotating magnetic field and in laminar flow. By combination of the experimental results the volume of the colloid particles, their elongation coeff. and the magnitude of the magnetic anisotropy can be defined. The investigation is an extension of previous studies of the authors [*Colloid. J.*, **11**, 197 (1949)] in which the coeff. of the rotatory diffusion and magnetic properties of the particles were determined from their optical behaviour in magnetic fields. Theory and experimental method are described in detail, and the results tabulated and graphed. B. F. KRAUS

541.183

1314. Diffusion and swelling of high polymers. III. Anisotropic swelling in oriented polymer film. G. S. HARTLEY. *Trans. Faraday Soc.*, **45**, 820–32 (*Sept.*, 1949).

The penetration of oriented cellulose acetate film in the plane of the film by various solvents and swellers has been examined qualitatively and roughly quantitatively. Penetration is much more rapid normal to the preferred direction of the macromolecular axes than parallel thereto, except in the case of certain "abnormal" solvents which are peculiar also in that they give rise to a sharply serrated front of attack in penetration of isotropic film. The magnitude of the difference in penetration rates of normal substances is very great and it is doubtful whether there is any penetration at all parallel to the macromolecular axes in highly oriented film securely clamped against lateral expansion. With less oriented film and oblique penetration there is also a quantitative abnormality in that depth of penetration is initially more nearly $\propto$ time than to (time)$^{\frac{1}{2}}$. Whether this anisotropic penetration is due to anisotropy of the pure diffusion process itself or of the swelling that accompanies it cannot be decided by the present work but it is probable that both factors are operative. [See Abstr. 5062–3 (1949)]. A.

541.183

1315. Statistical mechanics of adsorption. VI. Localized unimolecular adsorption on a heterogeneous surface. T. L. HILL. *J. Chem. Phys.*, **17**, 762–71 (*Sept.*, 1949).

The Langmuir isotherm for localized unimolecular adsorption is generalized (using statistical methods) in order to discuss adsorption on a heterogeneous surface, with and without interactions between adsorbed molecules. The configurational entropy, and the nature of the phase changes on a random heterogeneous surface are discussed. In particular, on this type of surface, the theory predicts, at least for one special case, that condensation will occur in two steps (instead of the customary one step) at low enough temps. A.

541.183

1316. Statistical mechanics of adsorption. VII. Thermodynamic functions for the B.E.T. theory. T. L. HILL. *J. Chem. Phys.*, **17**, 772–4 (*Sept.*, 1949).

As an application of the thermodynamic methods discussed in an earlier paper, thermodynamic functions are calculated from the B.E.T. statistical model. A.

541.183.26 : 533.15

Kinetics of the absorption of carbon dioxide in water. *See Abstr.* 776

541.183.5 : 531.72

Determination of surface area of a solid from an adsorption isotherm. *See Abstr.* 749

CHEMICAL STRUCTURE 541.4/.6

541.52

1317. Hydrogen bonding. V. L. ALBANSKY. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 1) 77–9 (1949) *In Russian.*

The co-ordination number of H is usually taken as 2 with a 4-electron cloud. It should be 1 or 2 with 2 or 4 electrons. Bonding like $CH_3CONH_2 . HCl$ is not $CH_3CONH_2 \rightarrow : H : Cl$ but should be written $[CH_3CONH_2 \rightarrow : H^+]^+/Cl^-$ giving H a co-ordination number 1, univalent with a 2-electron cloud. The apparently abnormal $(CH_3CONH_2)_2HCl$ is similarly $[CH_3CONH_2 \rightarrow : H^+ : \leftarrow CH_3CONH_2]^+/Cl^-$ not as has been customary

$$CH_3CONH_2 \rightarrow : H : \leftarrow CH_3CONH_2;$$
$$\dot{C}l$$

here H has co-ordination number 2, a cloud of 4 electrons, is singly charged and divalent, i.e. not abnormal. In the NH_3 group all H ions are equivalent and univalent, each may give rise to complex formation by becoming divalent with 4 electrons. J. JACOBS

541.57

1318. Bond energies and bond distances of branched paraffins. G. GLOCKLER. Letter in *J. Chem. Phys.*, **17**, 748 (*Aug.*, 1949).

541.57

1319. Bond energies and bond distances of the normal paraffins. G. GLOCKLER. Letter in *J. Chem. Phys.*, **17**, 747–8 (*Aug.*, 1949).

541.64

1320. Inequalities between average molecular weights of polymers, and their relations to the distribution function. G. HERDAN. Letter in *Nature, Lond.*, **164**, 502–3 (*Sept.* 17, 1949).

Relations between "average" molecular weights determined by different experimental methods.

N. L. JOHNSON

541.64 : 539.32

A method of measuring some dynamic elastic constants and its application to the study of high polymers. *See Abstr.* 1262

541.67 : 538.224

1321. The diamagnetic susceptibilities of phthalic acid and phthalic anhydride. B. K. SINGH, K. M. S. MANHAS, M. SINGH AND V. PURI. *Proc. Indian Acad. Sci. A*, **30**, 103–6 (*Aug.*, 1949).

CHEMICAL ANALYSIS 543/545

545.8

1322. The estimation of thorium in thoriated tungsten by radioactivity measurements. M. GALLET. *Vide*, **4**, 585–90 (*March*, 1949) *In French.*

A special G.M. counter is used consisting of a cylindrical counter with a thin Ni tube inserted parallel to the axis. The wire to be tested is fed through the Ni tube. A counter circuit working at up to 150 c.p.m. is described. It is calculated that the apparatus is capable of estimating the percentage of Th to within 10%. A. H. W. BECK

545.82

1323. On the exponent of the number of atoms in the expression for the intensity of emission of a spectrum ray. E. LOEUILLE. *Spectrochim. Acta*, **3** (*Nos* 5–6) 475–87 (1949) *In French.*

The Mn and Si contents of 3 steels were determined. The density difference, or intensity difference, of the 2 spectrum lines used in analysis, plotted against impurity concentration, gave a calibration line in each case. These lines were shifted for a given impurity by variation of the base metal concentration. Each spectrum line intensity is $\propto$ the mth power of the atomic concentration of the element emitting it in the source, and m can be calculated from the calibration line shift with an accuracy limited by the stability of the source and the uniformity of the photographic process. S. T. HENDERSON

545.82

1324. Emission spectrum analysis. W. ROLLWAGEN. *Spectrochim. Acta*, **3** (*Nos* 5–6) 603–15 (1949) *In German.*

A critical account of the contemporary aspect of the method from the fundamental standpoint, as shown by the analysis of 106 German publications in 1939–46. S. T. HENDERSON

545.82 : 771.534.

1325. Ideas concerning the problem of plate error H. DEHIO, J. EGGERT, M. HONERJÄGER-SOHM H. HÖRMANN AND H. KAISER. *Spectrochim. Acta*, (*Nos* 5–6) 488–97 (1949) *In German.*

A review of the factors which contribute to the photographic error of spectrochemical analysis is made under 3 headings: errors of manipulation defects of the emulsion and graininess. A

545.82 : 771.534.54

1326. On the inherent precision of spectrochemical computation. R. SCHMIDT. *Spectrochim. Acta*, (*Nos* 5–6) 538–45 (1949) *In English.*

A statistical treatment of the inherent precision of spectrochemical computation methods is given. For a given case, this precision can be increased by increasing the precision with which gamma of the emulsion is determined. If computations are carried out with gamma values, which are the mean of 4 independent determinations, the inherent precision very closely approximates its maximum value. A.

545.824

1327. Mineralogical analysis of clays by X-rays. D. M. C. MACEWAN. *Research, Lond.*, **20**, 459–66 (*Oct.*, 1949).

A general survey of the field, describing how the powder method is adapted to deal with clays, and the type of problems encountered. Bibliography of 23 items. R. B. SHEPHERD

CRYSTALLOGRAPHY 548

548.0 : 535.371

1328. Crystal size and fluorescence intensity. E. J. BOWEN AND P. D. LAWLEY. Letter in *Nature, Lond.*, **164**, 572–3 (*Oct.* 1, 1949).

The forcing of some of the fluorescent light of anthracene through the edges of the flat crystals produces through differential absorption in different sized crystals a difference in the ratio of intensities of the various vibrational bands. This effect is made use of to examine whether the apparent resonance transfer in anthracene-napthalene solid solutions [Abstr. 961 (1949)] is real or due to reabsorption. It is found that in the solid solutions of napthalene-acridine there is no difference in the band ratio as compared with napthalene itself, indicating that resonance transfer and not reabsorption occurs.

J. EWLES

548.0 : 536.7

1329. Thermodynamic conditions for the retention of solvents by crystals: the system brucine/benzene. H. KACSER AND A. R. UBBELOHDE. Letter in *Nature, Lond.*, **164**, 445–6 (*Sept.* 10. 1949).

Brucine crystallizes from benzene solutions with one molecule of benzene per brucine molecule and this solvent of crystallization is very firmly held as it does not come off until the crystals are heated to 140°C at atmospheric pressure. The authors discuss other examples of a similar character. From a thermodynamic point of view it is suggested that it may be significant that brucine solidifies from the melt to a glass and crystallizes with difficulty. Thermodynamic equations are developed to relate the free energies per mol. of the melt, and the crystal, to the respective specific heats and benzene vapour partial pressures. Putting in numerical values for the brucine/benzene system leads to the conclusion that a contributory factor in the tenacious retention of benzene is the high entropy of fusion. J. IBALL

548.0 : 539.32

1330. Elastic constants of lithium fluoride. R. V. G. SUNDARA RAO. *Curr. Sci.*, **18**, 336 (*Sept.*, 1949).

548.0 : 539.32

1331. Elastic constants of sodium chlorate and sodium bromate. R. V. G. SUNDARA RAO. *Curr. Sci.*, **18**, 204–5 (*June*, 1949).

The method previously described [Abstr. 5100 (1949)] gives for the elastic moduli and the compressibility of $NaClO_3$ and $NaBrO_3$ the values $s_{11} = 23{\cdot}5,\ 22{\cdot}4$; $s_{12} = -5{\cdot}30,\ -5{\cdot}8$; $s_{44} = 84{\cdot}1,\ 66{\cdot}7$; $\beta = 38{\cdot}7,\ 32{\cdot}4$ respectively, all in units of 10^{-13} cm² per dyne. A. J. C. WILSON

548.0 : 539.32

1332. Note on the potential energy of KH_2PO_4. Applications to the calculation of Poisson coefficients and binding constants. J. CHAPELLE. *C.R. Acad. Sci., Paris*, **228**, 648–50 (*Feb.* 21, 1949) *In French.*

A particular deformation energy is taken; with the assumption of an inverse 9th power law of repulsion between ions and of central forces, Poisson's ratios $\sigma_{ik} = s_{ik}/s_{kk}$ are calculated, together with the constants k_i of the binding forces. The results are compared with Zwicker's [Abstr. 1038 (1947)] experimental results. J. E. CAFFYN

548.0 : 539.6

1333. Theory of elastic dissipation in monocrystals according to quantum mechanics: a new relaxation effect. P. G. BORDONI. *Ric. Sci.*, **19**, 851–62 (*Aug.*, 1949) *In Italian.*

A theory is presented of the motion—produced by a small stress and by thermal fluctuations—of dislocations in metal crystals. This motion causes a permanent deformation variable in time according to the law $E = E_0[1 - \exp(-t/T)]$. T increases at low temps. and becomes very large below the Debye temp. A new relaxation effect arises thereby in this region of temp., observed through the damping of acoustical vibrations in the crystal. Experiments on crystals of Pb, Ag, Al, Cu have completely verified the theory. L. PINCHERLE

548.0 : 539.42

1334. A method of determination of the *z*-axis on *x*-cut quartz plates and directions of easy breaking of quartz plates. O. NOMOTO. Letter in *Nature, Lond.*, **164**, 359–60 (*Aug.* 27, 1949).

548.25

1335. Solid solutions in the $CaCO_3$–$SrCO_3$ system investigated by the emanation method. H. KALLWEIT. *Z. Naturforsch.*, **4a**, 140–9 (*May*, 1949) *In German.*

Crystals of (Ca, Sr)CO_3 containing a small quantity of ThX were prepared, and the rate of release of thoron was studied as a function of the temp. (room temp. to 1 400°C). The temps. of polymorphic transitions could be inferred from peaks in the curve. The aragonite → calcite (orthorhombic → hexagonal) transformation temp. increases linearly with increasing mol-% Sr from approx. 490° for $CaCO_3$ to approx. 900° for $SrCO_3$. At approx. 50% Sr the aragonite form becomes stable at room temp. The transition is complex in the neighbourhood of 70% Sr. Crystals prepared by precipitation at 20° (instead of 75°) or by decomposition of the oxalate *in vacuo* (instead of in air) showed lattice defects.

A. J. C. WILSON

548.33

1336. The linear velocity of polymorphic transformations. N. H. HARTSHORNE. *Disc. Faraday Soc.* (*No.* 5) 149–58 (1949).

A general expression is derived for the linear rate of transformation in terms of the activation energies of escape of molecules from the two crystal modifications. Measurements were made of the linear rate of transformation of monoclinic to rhombic sulphur between 0° and 80°C. The experimental results deviated from the theoretical curve in the high temp. region. This may be due to a variation in the rate of escape of molecules from the rhombic form, or to a nucleation effect. J. A. FRANKS

548.5

1337. General principles of crystal growth. P. H. EGLI AND S. ZERFOSS. *Disc. Faraday Soc.* (*No.* 5) 61–79 (1949).

Factors controlling nucleation and crystal growth are briefly discussed. Experimental evidence is given that a highly associated solute is favourable to flawless growth, since nuclei are then formed only with large supersaturations. Small concentrations of foreign ions may greatly increase the range of supersaturation within which spontaneous nucleation does not take place. J. A. FRANKS

548.5 : 534.321.9

1338. The effect of ultrasonics on the formation of metal crystals by electrolytic deposition. F. A. LEVI. *Ric. Sci.*, **19**, 887–91 (*Aug.*, 1949) *In Italian.*

548.5 : 535.81

Artificial fluorite. *See Abstr.* 907

548.51 : 538.65

1339. Production of crystal nuclei oriented by a magnetic field. Sulphates of the magnesium series. J. BLANDIN. *C.R. Acad. Sci., Paris*, **228**, 1718–20 (*May* 30, 1949) *In French.*

By crystallizing on a sheet of glass in a field of 15 000 gauss, oriented nuclei are produced. The resulting crystals of the orthorhombic sulphates of Mg, Zn and Ni are elongated perp. to the field, and produce extinction between crossed nicols when the direction of the field or of greatest elongation coincides with the direction of polarization. Monoclinic or triclinic crystals may possess 2 directions of orientation and of extinction and the angle between them is characteristic of the particular crystal. Data are given for various substances, including double sulphates of NH_4 or K and Mg, Cu, Fe, Co, Ni, Zn and Mn. C. E. WEBB

548.52

1340. Oriented overgrowths and stabilization at ordinary temperatures of the cubic (I), tetragonal (II) and orthorhombic (III) phases of ammonium nitrate. R. HOCART AND A. MATHIEU-SICAUD. *Disc. Faraday Soc.* (*No.* 5) 237–42 (1949).

Oriented overgrowths of the various polymorphic forms of NH_4NO_3 deposited from melt or solution on mucovite mica were studied with a polarizing microscope. The development of fissures resulting from changes in polymorphic form indicates the degree of correspondence between the densely packed planes of the various forms. Ammonium nitrate I, II, III were stabilized at ordinary temps. by addition of impurities with lattice constants corresponding to those of a particular polymorphic form.

J. A. FRANKS

548.52

1341. Crystal growth and surface structure. I. W. K. BURTON AND N. CABRERA. *Disc. Faraday Soc.* (*No.* 5) 33–9 (1949).

The equilibrium structure and rate of growth of an infinite surface are discussed. Crystal surfaces may either be close-packed (when flat all surface molecules are at the same distance from a plane parallel to the surface) or stepped. Deposition on the edge of a step

does not require a linear nucleation process, since steps contain kinks, adsorbed molecules and holes, the density of which is a function of the temp. The growth of close-packed surfaces at low supersaturations depends on the jump concentration (differences in level). Below a critical temp. the jump concentration is negligible and surface nucleation is necessary, above that temp. no nucleation is required and rapid growth will occur. J. A. FRANKS

548.52

1342. Crystal growth and surface structure. II. N. CABRERA AND W. K. BURTON. *Disc. Faraday Soc.* (*No.* 5) 40–8 (1949).

The kinetic problem of the growth of close-packed and stepped surfaces is treated. In all cases it is necessary to consider the diffusion of adsorbed atoms on the surface of the crystal. Formulae are given for the growth of stepped surfaces as a function of the inclination. The growth of close-packed surfaces below their critical temp. by the mechanism of 2-dimensional nucleation is considered, taking diffusion into account, but the theory does not agree with experiment. A treatment of the initiation of growth of an imperfect crystal containing a random distribution of dislocations is given and shown to be in agreement with experiment. J. A. FRANKS

548.52

1343. The influence of dislocations on crystal growth. F. C. FRANK. *Disc. Faraday Soc.* (*No.* 5) 48–54 (1949).

The theoretical supersaturation of vapour required for self-nucleation of fresh 2-dimensional monolayers of molecules on a crystal face considerably exceeds the actual supersaturation. Real crystals contain a certain number of dislocations with a screw component terminating at the surface, thus always exposing molecular terraces on which growth continues; the need for fresh 2-dimensional nucleation therefore never arises. The effects of combinations of screw dislocations on growth are discussed, and a brief account is given of the origin of dislocations.

J. A. FRANKS

548.522

1344. "Vapour snakes" in *cyclo*hexane. M. K. PHIBBS AND H. I. SCHIFF. Letter in *J. Chem. Phys.*, 17, 843–4 (*Sept.*, 1949).

A description is given of a phenomenon observed during the crystallization of symmetrical compounds—but most strikingly in *cyclo*hexane. Photographs are included and tentative explanations are advanced.

W. R. ANGUS

548.523

1345. Kinetics of crystallization in solution. I. S. H. BRANSOM, W. J. DUNNING AND B. MILLARD. *Disc. Faraday Soc.* (*No.* 5) 83–95 (1949).

A relation is derived giving the size distribution of crystals under conditions of continuous crystallization as a function of the supersaturation and growth. Cyclonite was continuously precipitated from soln. in conc. HNO_3 by addition of water. The particle size distribution was obtained by means of a photo-electric sedimentometer. The rate of linear growth was found to be a linear function of the supersaturation, and the rate of nucleation an approximately cubic function. The results are discussed in relation to the Becker–Döring theory [*Ann. Physi* **24** (5), 719 (1935)]. J. A. FRANK

548.52

1346. Kinetics of crystallization. II. S. H BRANSOM AND W. J. DUNNING. *Disc. Faraday Soc* (*No.* 5) 96–103 (1949).

Relations are given for obtaining the growth ar nucleation rates under conditions of sudden supe saturation from measurements of the particle si distribution. The initial supersaturation was brough about by the addition of water to a conc. solutio of cyclonite in acetone. The nucleation rate wa found to depend only on the supersaturation and no on the presence of crystals; there is no evidence fo auto- or secondary-nucleation. J. A. FRANK

548.52

1347. Crystal growth from solution. I. Laye formation on crystal faces. C. W. BUNN AN H. EMMETT. *Disc. Faraday Soc.* (*No.* 5) 119–32 (1949)

The fine structure of growing faces and the manne of deposition of solute are studied. Layers generall originate at the centres of faces spreading outward towards the edges, the thickness of the layers increase on approaching the edges of the crystal faces. Th boundaries of the layers are often irregular for hig growth rates; for low rates the shape conforms to th symmetry of the crystal face. Dissolved impurities may strongly influence the thickness and shape of the layers. Thick layers (up to 5 000 Å) were observed on crystals of ionic substances, but were not formed on non-polar crystals. J. A. FRANKS

548.52

1348. Crystal growth from solution. II. Concentration gradients and the rates of growth of crystals C. W. BUNN. *Disc. Faraday Soc.* (*No.* 5) 132–4 (1949).

Variations in the concentration of the solution in the neighbourhood of growing $NaClO_3$ crystals were observed by means of an interference method. The supersaturation was greatest at the edges and least at the centre of each face. No correlation could be found between rate of growth and supersaturation; faces of one crystal, though all of the same type (100), usually grew at different rates. Consideration of the diffusion field shows that excess solute is delivered to the centre of the faces, where new growth layers originate. An interrelation may exist between surface profile and concentration gradients. J. A. FRANKS

548.523

1349. The growth of individual faces of cubic sodium chlorate crystals from aqueous solution. S. P. F. HUMPHREYS-OWEN. *Disc. Faraday Soc.* (*No.* 5) 144–9 (1949).

Relations are given between growth rate and concentration which lead to Nernst's formula for growth from solution. The growth of $NaClO_3$ crystals and concentration gradients were observed by Bunn's method [preceding Abstr.]. Some (100) faces obeyed Nernst's formula, the concentration at the face centre then corresponding to saturation. Faces growing at slower rates were in contact with supersaturated solution; abrupt changes occurred in the growth rate. An empirical formula is given for the Bunn distribution of concentration along a face.

J. A. FRANKS

548.523

1350. The relative rates of growth of strained and unstrained ammonium nitrate crystals. S. FORDHAM. *Disc. Faraday Soc.* (*No.* 5) 117–19 (1949).

The rate of growth of the strained ammonium nitrate crystals from solution was found to be the greater. The results indicated that the effect of straining was eliminated after a thin layer had been deposited, but that crystallization initially exceeded the normal rate by at least 20%. J. A. FRANKS

548.523

1351. Growth and dissolution of crystals under linear pressure. C. W. CORRENS. *Disc. Faraday Soc.* (*No.* 5) 267–71 (1949).

An expression is derived for the equilibrium concentration of a solution with a crystal under pressure. Alum crystals were grown under pressure in supersaturated solutions. Deviations from the theoretical equilibrium concentration curve occurred at high pressures, owing to phase boundary forces between crystal and pressure plate, which differed for the various crystal faces. Similar effects were observed with crystals dissolved under a linear pressure.

J. A. FRANKS

548.523

1352. The influence of foreign ions on crystal growth from solution. I. The stabilization of the supersaturation of calcium carbonate solutions by anions possessing O-P-O-P-O chains. B. RAISTRICK. *Disc. Faraday Soc.* (*No.* 5) 234–7 (1949).

Considerations of the structure of calcite and of the probable structure of the polymetaphosphate anion show that the anion fits in the Ca layer of calcite, preventing further growth of nuclei and thus stabilizing supersaturated $CaCO_3$ solutions. The behaviour of various anions with similar structures is briefly discussed. J. A. FRANKS

548.524

1353. Crystal growth at high temperatures. S. ZERFOSS, L. R. JOHNSON AND P. H. EGLI. *Disc. Faraday Soc.* (*No.* 5) 166–72 (1949).

A summary is given of the methods of crystal growth from anhydrous melts and vapours. Bridgman's moving crucible technique developed by Stockbarger [*Rev. Sci. Instrum.*, **7**, 133 (1936)] and the Verneuil technique are described. The Verneuil method has recently been used to grow single crystals of rutile and scheelite. J. A. FRANKS

548.524

1354. Some aspects of the growth of quartz crystals. A. C. SWINNERTON, G. E. OWEN AND J. F. CORWIN. *Disc. Faraday Soc.* (*No.* 5) 172–80 (1949).

Quartz crystals were grown in dilute alkali halide solutions at 400°C with zero thermal gradient, utilizing vitreous silica as source material and crystalline seed plates. Apparatus was developed to record automatically the impedances of the liquid and vapour phases as they approach and pass into the supercritical state. Theoretical interpretations are given regarding the nature of the SiO_2–H_2O-metal ion relationships. J. A. FRANKS

548.524

1355. The role of diffusion potentials in the growth of ionic crystals. A. R. UBBELOHDE. *Disc. Faraday Soc.* (*No.* 5) 180–2 (1949).

The various types of impurity, which affect the diffusion potentials due to concentration gradients in the solution in the neighbourhood of ionic crystals, are briefly discussed. A potential gradient exists across the interface between the lattice and the soln. even under conditions where growth rates are negligible. On applying an electric field, cataphoresis may occur of crystal nuclei in solution. J. A. FRANKS

548.53

1356. Boundary migration and grain growth. W. C. MCCRONE. *Disc. Faraday Soc.* (*No.* 5) 158–66 (1949).

Boundary migration in the octachloropropane and DDT types of crystal lattice is mainly caused by lattice strain due either to cold working or temp. changes. Grain shape largely controls the grain growth of octachloropropane type crystals (including metals); migration in compounds of the DDT type depends on the relative orientation of the neighbouring crystals. J. A. FRANKS

548.53 : 539.26

1357. Precipitation in alloys. A. GUINIER. *Physica*, **15**, 148–60 (*April*, 1949) *In French.*

An account of precipitation from supersaturated solid solutions as revealed by X-ray diffraction methods. When the difference in diameter of the two kinds of atoms is small, the nuclei tend to be spherical; when this difference is great the nuclei are plates. The formation and growth of the nuclei are considered and also the effect of strain and annealing.

A. E. DE BARR

548.538

1358. Misfitting monolayers and oriented overgrowth. J. H. VAN DER MERWE. *Disc. Faraday Soc.* (*No.* 5) 201–14 (1949).

The conditions necessary for the formation of an oriented monolayer on a crystalline substrate are described. The effects of dislocations on the orientation of the overgrowth are discussed; for oriented overgrowth there must exist the possibility of a strong chemical bond between the units of the overgrowth and the corresponding units of the substrate. Tables are given of the different types of substrate and deposit. J. A. FRANKS

548.54

1359. Surface structures of ionic crystals. K. MOLIÈRE, W. RATHJE AND I. N. STRANSKI. *Disc. Faraday Soc.* (*No.* 5) 21–32 (1949).

The surface structures caused by the effect of ionic polarizability are obtained for the rock salt type lattice. For large polarizabilities adjacent ions along the edges and on the faces collect to form small isolated molecular complexes with a lower symmetry than the space lattice. No direct experimental evidence has yet been obtained. J. A. FRANKS

548.54

1360. The effect of dyes on the crystal habits of some oxy-salts. A. BUTCHART AND J. WHETSTONE. *Disc. Faraday Soc.* (*No.* 5) 254–61 (1949).

Tables are given of the effect of dyes on the

habits of NH_4NO_3 IV, $(NH_4)_2SO_4$, KNO_3 and $NaNO_3$ crystals. In all cases, the crystal planes, on which growth was limited by the dyes, consisted of alternate positive and negative ions. J. A. FRANKS

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 537.531

1361. Electron states in a disturbed crystal structure. E. I. ADIROVICH. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 2) 111–14 (1948) *In Russian.*

Ions immediately surrounding a missing anion in an ionic lattice are replaced by a spherical electrical double layer which can vibrate about its equilibrium radius. Energy may be exchanged between layer and electron but not with lattice. Characteristic radii x_n are determined for which discrete electron levels $W_n(< 0)$ coincide with the bottom of energy zone. For a further decrease in radius, electronic energy remains constant, and the electron is uniformly distributed with infinitely small probability density. For $W < 0$, the density of electronic charge cloud decreases outside the double layer and vanishes identically at origin. Hence the electron is trapped in a potential well inside the double layer; decrease in energy on localization equals work done by attraction of double layer. Since the system layer-electron is adiabatic, inclusion of electron into layer must be accompanied by an energy increase of layer, attributed to the force with which the electron tends to increase the layer radius. J. JACOBS

548.7 : 537.533.92

1362. Distribution of the ionization density in a KCl crystal which is irradiated with high-velocity electrons. H. BERGER AND W. PAUL. *Z. Phys.*, **126** (*No.* 5) 422–30 (1949) *In German.*

The maximum of ionization was found to be in one-third of the active range of the electrons, which is independent of their energy (2–6 MeV). The ionization density was measured by photometering the purple colour centres in the KCl crystal. A crystal was repeatedly used for measurements, the colour centres of the previous experiment having been wiped out by irradiating the crystal with white light. The maximum of ionization is explained as the superposition of the individual dispersion patterns. W. SUMMER

548.734 : 537.226.8

1363. Effect of external stress on X-ray intensity reflected from Rochelle salt crystal. S. MIYAKE. *J. Phys. Soc. Japan*, **2**, 98–102 (*Sept.–Oct.*, 1947).

Observations of the intensity of X-ray reflections from a Rochelle salt crystal subjected to external stress can be explained on the assumption of tetragonal domains in the crystal. The intensity increases with increasing stress due to a reduction of the extinction effect, but at the same time the domain structure gradually disappears and only reappears some time after the removal of the stress. A. E. DE BARR

GEOPHYSICS 55

550.367 : 539.172

The neutrinos from the sun and the source of the earth's heat. *See Abstr.* 1205

550.38 : 538.082

Airborne magnetometer for measuring the earth's magnetic vector. *See Abstr.* 1065

ATMOSPHERE . METEOROLOGY 551.5

551.508.5 : 533.6.08

New anemometers. *See Abstr.* 789–91

551.508.7 : 621.317.39

1364. Dew-point recorder. S. S. STACK. *Gen. Elect. Rev.*, **52**, 42–5 (*April*, 1949).

The mirror is continuously cooled by a 2-stage freon refrigerator capable of producing $-100°$F. The light reflected from the mirror is compared, by means of two photo-cells, with a direct ray from the same lamp; the photo-cell output is amplified and controls, by means of a thyratron, an electric heater on the mirror which is thus maintained at the dew-point. A thermocouple operates a temp. recorder, of range -100 to $+100°$F. The time constant of the system is 25 sec, under dew conditions; in the frost zone the time lag is greater, especially when the frost-point is falling. A gas flow between $\frac{1}{50}$ and $\frac{1}{4}$ ft³/min is required. The accuracy is 2°F above $-20°$F and 5°F down to $-90°$F. The apparatus is mounted in a cabinet rack and requires 115 V, 60 c/s supply. C. F. BROCKELSBY (R)

551.508.85 : 621.396.9

1365. Radar as an aid to the study of the atmosphere. F. E. JONES. *J. Roy. Aero. Soc.*, **53**, 433–48 (*May*, 1949).

The results of experiments by the Meteorological Office and T.R.E. are described. These included precipitation, detection of clouds dangerous to flying, and the measurement of cloud height, wind speed and wind direction. An account of the use of radar in measuring density at heights $> 70\,000$ ft., and some of the problems still to be solved in radar sonde design for measuring pressure, temperature and humidity profiles. INDEX AERONAUTICUS

551.510.535 : 621.396.11

1366. The ionosphere and the propagation of radio waves. J. A. RATCLIFFE. *Nature, Lond.*, **164**, 511–13 (*Sept.* 24, 1949).

Brief summary of papers presented at a conference held in Cambridge, England, in July, 1949, under the title given. W. J. G. BEYNON

551.515.4 : 621.396.82

1367. Low-frequency components of atmospheric pulses and their origin. S. R. KHASTGIR AND R. ROY. Letter in *Nature, Lond.*, **164**, 488–9 (*Sept.* 17, 1949).

A note on atmospheric wave-form observations showing (1) a slow component ahead of the aperiodic or quasi-periodic pulse, (2) slow components on either side of the h.f. group, and (3) a slow component following the h.f. group. Suggestions for the origin of such components are made. W. J. G. BEYNON

BIOLOGY 57/59

591.18 : 621.317.757

1368. Frequency analyser for bioelectric potentials in the sub-audio range. C. MARKEY, R. L. SCHOENFELD AND P. F. A. HOEFER. *Rev. Sci. Instrum.*, **20**, 612–16 (*Aug.*, 1949).

An analyser for sub-audio bioelectric potentials, particularly the human electroencephalogram (EEG), is described. The instrument is coupled to the output of a standard EEG amplifier and records 20 frequencies by means of individual filters each coupled to a 2 in c.r.o. A 35 mm slow moving camera provides a time base while simultaneously photographing the filter deflections, a cathode-ray trace of the unanalysed slow wave and 1 sec time markers produced by a clock-driven flashing light. The system employs amplitude modulation of a 1 200 c/s carrier; the filters being selective to the lower sideband frequencies which are recorded as horizontal deflections of the oscilloscopes. The present analyser has a $\frac{1}{2}$ sec time constant and is thus a low "Q" system responsive to activity of short duration. The frequency spectrum obtained is necessarily broad but detailed in the time domain, an aspect of physiological importance hitherto neglected. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84

1369. Focusing wave-length for white light. A. IVANOFF. *J. Opt. Soc. Amer.*, **39**, 718 (*Aug.*, 1949).

The wavelength for which an eye is focused when viewing white light depends on the accommodation of the eye. It is red for the unaccommodated eye, and gradually changes to bluish-green for an accommodation of more than 2·5 dioptres. This variation is probably correlated with the variation of the spherical aberration under similar circumstances. The experimental arrangements are shown, and a graph gives the mean results for 9 eyes. R. A. WEALE

614.485

1370. Air disinfection by germicidal ultraviolet energy. M. LUCKIESH, A. H. TAYLOR AND T. KNOWLES. *Gen. Elect. Rev.*, **52**, 34–7 (*Aug.*, 1949).

Bacterial diseases are communicated by (*a*) direct contact, (*b*) breathing air contaminated by sneezing, etc. Ordinary ventilation may stir up infected dust and increase the risk of contamination, apart from the discomforts of draughts and cold. To overcome these objections, apparatus has been produced whereby incoming air is submitted to germicidal short-wave u.v. light, safeguards being taken to avoid this light affecting the eyes and inducing conjunctivitis. The authors have designed air-samplers to measure contamination due to various organisms. Many organisms arise otherwise than from the respiratory tract and no one culture medium will alone grow one particular bacillus, or one particular bacillus serve as an index of total contamination, whilst viruses cannot be detected by ordinary sampling and cultural techniques. This air-sampling apparatus is described in detail, a vacuum pump drawing air through two identical sampling units, to issue at high velocity upon culture media. Experiments have been conducted with infected air and atomized saliva. Tests show the rapidity with which infected air can be sterilized by u.v. light. It has been shown one 30 W germicidal lamp is sufficient to sterilize a room of 200–300 ft² floor area. From an economic aspect it is claimed that saving loss of one day's work by one worker once a year justifies u.v. air purifying. There is application to workshops, schools and barracks, apart from general aspects of disease prevention. B. J. LEGGETT

615.849

1371. Some calculations on the γ-ray dose produced by a 14 MeV betasynchrotron using an internal target. D. J. ALLEN-WILLIAMS AND R. K. APPLEYARD. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 2) 305–10 (1949).

Relations are derived between the dose in r/min and the mean electron current in a synchrotron. On the first electron transit through the target the fraction of K.E. converted into photons is low, but multiple traversal is possible. On rather crude assumptions, r (r/min at 1 metre) $= 9{\cdot}4\,i$ (μA) for 1 passage in a 12 MeV machine, and from the observed value of r, $i = 2{\cdot}1\times10^{-8}$ A. For a thick target $i = 2{\cdot}1\times10^{-10}$ A, and experimentally $i < 2{\cdot}1\times10^{-9}$ A; $\therefore$ multiple traversal probably occurs. More detailed calculation supports this view, and radial oscillations of electrons in synchrotron orbits are shown to cause multiple traversal by groups of electrons. Representative values of radial, vertical and angular displacement of these groups are tabulated and some possible effects are discussed. T. G. PICKAVANCE

615.849 : 537.534

A 30-million volt synchrotron for medical use. *See Abstr.* 1009

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666 : 539.532

A hardness table for optical glass. *See Abstr.* 1280

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771.53 : 538.563

Photochemical effects produced by Maxwell's currents. *See Abstr.* 1091

771.531 : 537.531

1372. Granularity measurements of X-ray emulsions exposed to X-rays with increasing quantum energy. R. H. HERZ. *Photogr. J.*, **89B**, 89–96 (*July–Aug.*, 1949).

X-ray emulsions exposed to X-rays of increasing hardness show an increase of granularity up to short wavelengths of the order of 0·1–0·04 Å, as measured with a photoelectric granularity meter. At still shorter wavelengths (1 000 kV and γ radiation) the granularity decreases slightly. The percentage increase of granularity changes with the type of emulsion. It is believed that the increase of granularity is due to group formation of developed AgBr grains mainly caused by photo- and recoil-electrons released by higher energy quanta. The different behaviour of various emulsions with regard to the increase of granularity is supposed to be influenced by the mean distance between grains of different emulsions. Exposures with water-swollen films and with emulsions having different Ag-gelatin ratio show some evidence that the separation of grains is partly responsible for the effect. From the speed relationship between dry and wet emulsions exposed to X-rays of different hardness, conclusions were drawn that more grains are made developable per absorbed quantum of high energy compared with a quantum of low energy. A.

778.3

1373. The removal of the background of tracks of charged particles in photographic emulsions by means of accelerated fading. G. E. BIELOVITSKY AND L. V. SUCHOV. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 2) 243 (1948) *In Russian.*

Reports briefly an investigation showing that storage in a humid atmosphere quickly removes the latent images produced by the passage of protons and α-particles through a photographic emulsion. After drying, the plates were shown to have returned to normal sensitivity. E. P. GEORGE

778.3

1374. Calibration of photographic emulsions for low energy electrons. L. CRANBERG AND J. HALPERN. *Rev. Sci. Instrum.*, **20**, 641–5 (*Sept.*, 1949).

Measurements are reported for the dependence on energy of photographic darkening due to electrons of energies between 4·4 and 45 keV. For Ilford *B*-2 plates, in the linear density exposure region, the results can be expressed by the empirical formula $D/(Q/A) = KE^x$. D is the photometric density, Q/A the exposure in electrons/mm^2, E the energy in electron-volts; K and x are constants with the values $(0{\cdot}30 \pm 0{\cdot}03) \times 10^{-12}$ and $1{\cdot}45 \pm 0{\cdot}05$, respectively. The relationship for two other emulsions tested is complicated by the presence of surface coatings on the emulsions. Reproducibility of results is discussed. Results are given on density fluctuations due to granularity of Ilford and X-ray emulsions. The limit of sensitivity, using a recording microphotometer with a scanning beam 1·0 by 1·3 mm, is estimated at 450 electrons/mm^2 of 40 keV energy for the X-ray emulsion and 680 electrons/mm^2 for the Ilford plates. The latter is limited by photometric sensitivity. A.

778.3 : 536.46

1375. Photographic techniques in combustion research, L. BERAL. *Photogr. J.*, **89 B**, 98–107 (*Sept.–Oct.*, 1949).

A discussion on photographic methods applied in recent years to the study of combustion; description of camera and its equipment with special reference to and illustrations of the Pyroscope used by the author. The special technique developed for taking still- and moving-pictures is presented, including a survey of photographic methods for the determination of the temperature of flames or other combustion phenomena. Survey of existing literature, photographic recordings and tables. A.

778.3 : 537.591.8

The influence of an electric field on the number of nuclear disintegrations observed on photographic plates. *See Abstr.* 1064

778.3 : 539.16.08

The detection of Ca^{45}, I^{131}, P^{32} and Zn^{65} by photographic film. *See Abstr.* 1153

778.3 : 539.174.3

Investigation of nuclear photoprocesses in light elements with photographic method. *See Abstr.* 1219

778.3 : 539.185

Thermal neutral counting by the photographic method. *See Abst.* 1248

778.33 : 616–073.75

1376. Impulse radiography of living objects. M. F. POPOV AND E. A. LIKHTENSHTEIN [LICHTENSTEIN]. *Dokl. Akad. Nauk, SSSR*, 65 (*No.* 4) 489–91 (1949) *In Russian.*

778.37 : 621.327.4

1377. A high-intensity light source for high-speed cinematography. E. J. G. BEESON. Letter in *Nature, Lond.*, **164**, 453–4 (*Sept.* 10, 1949).

As in high-speed cinematography the total exposure rarely exceeds 3 sec it is possible to adopt unconventional methods to obtain the necessary light intensity. A high-pressure d.c. Hg vapour lamp of 1 kW, with special electrodes, can be overloaded to 10 kW for 1 sec or 4 kW for 3 sec, giving, in an 18 in dia. reflector, an average of 500 000 ft-candles over a 10 in. dia. circle at 3 ft. The light can be modified by addn. of Cd metal for colour work.

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